

Original Research



Meets Learning Need Codes 2030, 3000, and 4000. To take the Continuing Professional Education quiz for this article, log in to ADA's Online Business Center at www.eatright.org/obc, click the "Journal Article Quiz" button, click "Additional Journal CPE Articles," and select this article's title from a list of available quizzes.

Dietary Sources of Energy, Solid Fats, and Added Sugars among Children and Adolescents in the United States

JILL REEDY, PhD, MPH, RD; SUSAN M. KREBS-SMITH, PhD, MPH, RD

ABSTRACT

Objective The objective of this research was to identify top dietary sources of energy, solid fats, and added sugars among 2- to 18-year-olds in the United States.

Methods Data from the National Health and Nutrition Examination Survey, a cross-sectional study, were used to examine food sources (percentage contribution and mean intake with standard errors) of total energy (data from 2005-2006) and energy from solid fats and added sugars (data from 2003-2004). Differences were investigated by age, sex, race/ethnicity, and family income, and the consumption of empty calories—defined as the sum of energy from solid fats and added sugars—was compared with the corresponding discretionary calorie allowance.

Results The top sources of energy for 2- to 18-year-olds were grain desserts (138 kcal/day), pizza (136 kcal/day), and soda (118 kcal/day). Sugar-sweetened beverages (soda and fruit drinks combined) provided 173 kcal/day. Major contributors varied by age, sex, race/ethnicity, and income. Nearly 40% of total energy consumed (798 of 2,027 kcal/day) by 2- to 18-year-olds were in the form of empty calories (433 kcal from solid fat and 365 kcal from added sugars). Consumption of empty calories far exceeded the corresponding discretionary calorie allowance for all sex-age groups (which range from 8% to 20%). Half

of empty calories came from six foods: soda, fruit drinks, dairy desserts, grain desserts, pizza, and whole milk.

Conclusions There is an overlap between the major sources of energy and empty calories: soda, grain desserts, pizza, and whole milk. The landscape of choices available to children and adolescents must change to provide fewer unhealthy foods and more healthy foods with less energy. Identifying top sources of energy and empty calories can provide targets for changes in the marketplace and food environment. However, product reformulation alone is not sufficient—the flow of empty calories into the food supply must be reduced.

J Am Diet Assoc. 2010;110:1477-1484.

J. Reedy is a nutritionist and S. M. Krebs-Smith is chief, Risk Factor Monitoring and Methods Branch in the Applied Research Program with the Division of Cancer Control and Population Sciences at the National Cancer Institute, Bethesda, MD.

Address correspondence to: Jill Reedy, PhD, MPH, RD, Division of Cancer Control and Population Sciences, National Cancer Institute, 6130 Executive Blvd, MSC 7344, Bethesda, MD 20892. E-mail: reedyj@mail.nih.gov

Manuscript accepted: May 6, 2010.

Published by Elsevier Inc. on behalf of the American Dietetic Association.

0002-8223/\$0.00

doi: 10.1016/j.jada.2010.07.010

In the United States today, more than 23 million children and adolescents are overweight or obese (1,2).

Excess body weight, poor diet, and sedentary behavior have been associated with an increased risk of many chronic diseases, including hypertension, dyslipidemia, and type 2 diabetes, as well as depression, poor self-esteem, and associated quality-of-life issues (3,4). Although overweight and obesity are found in all subpopulations, the burden is particularly striking among children, adolescents, and underserved populations. Children and adolescents are now experiencing weight-related chronic diseases once seen only among adults. In addition, the prevalence of overweight is higher among adolescents compared to younger children, Mexican-American boys compared to non-Hispanic black or white boys, and Mexican-American and non-Hispanic black girls compared to non-Hispanic white girls (2).

Multiple factors influence overweight and obesity rates but, ultimately, an imbalance between energy consumed and energy expended is the determining factor. The current environment (including food stores, restaurants, schools, and worksites) and customs surrounding food in the United States have been labeled "obesogenic" and "toxic" due to the contributions made to this imbalance by large portion sizes, snacking, away-from-home meals, and consumption of sugar-sweetened beverages (5-7). Ironically, in a food environment that supplies an over-

abundance of energy, there are too few vegetables, whole grains, fruits, and milk products (8). Therefore, US children and adolescents do not always consume the types and amounts of food they need to support an active, healthy lifestyle (9).

Recommendations for fruits, vegetables, whole grains and other nutrient-bearing food groups are available in the 2005 Dietary Guidelines for Americans and MyPyramid (10,11). These resources also define the concept of a discretionary calorie allowance to provide limits for excess energy from consumption of food groups beyond recommended amounts and all energy from solid fats, alcoholic beverages, and added sugars. These represent empty calories, or sources of energy with virtually no nutritional value, and have been examined previously in relation to discretionary calorie allowances (12). Although the discretionary calorie allowance should be considered an upper boundary on consumption of energy from solid fats, alcoholic beverages, and added sugars, such intakes far exceed the recommended discretionary calorie allowances across all sex–age groups in the US population (13). The purpose of this research was to identify the top as eaten food sources of energy, solid fats, and added sugars among US children and adolescents. As eaten food sources include composite foods (eg, cookies), and mixed dishes (eg, pizza), as well as discrete foods (eg, milk or apples).

METHODS

Data Source and Sample

Data from the National Health and Nutrition Examination Survey (NHANES), a cross-sectional study, were used to examine food sources of total energy (during years 2005-2006) and energy from solid fats and added sugars (during years 2003-2004). NHANES is a nationally representative survey with a complex multistage, stratified probability sample. Trained interviewers conducted in-person 24-hour dietary recalls with all eligible persons, using automated data collection systems that included multiple passes. Survey participants aged 12 years and older completed the dietary interview on their own, proxy-assisted interviews were conducted with children aged 6 to 11 years, and proxy respondents reported for children younger than age 5 years (14). The NHANES protocol was approved by the National Center for Health Statistics Research Ethics Review Board, Hyattsville, MD, and all participants provided informed consent. Further information regarding the design of NHANES, including sampling and weighting procedures, can be found at www.cdc.gov/nchs/nhanes.htm.

Defining a List of Specific Foods

NHANES dietary intake data are catalogued according to discrete codes representing foods as eaten. For this analysis, food codes representing similar foods were combined to provide an indication of the contribution of distinct foods as eaten to the consumption of energy, solid fats, and added sugars. That is, the food codes reported by 2- to 18-year-olds during any of the years examined were sorted into 96 mutually exclusive food categories, which are hereafter referred to as specific foods. The list of specific foods (Figure 1) was adapted from earlier analyses (15-17) and has been used in a previous project (18).

Defining Energy from Solid Fats and Added Sugars

The US Department of Agriculture's (USDA) MyPyramid Equivalents Database (MPED) (version 2.0, 2006, US Department of Agriculture, Agricultural Research Service, Hyattsville, MD) was used to estimate energy from solid fats and added sugar (MPED values for grams of solid fat and teaspoons of added sugars were converted based on 9 kcal/g and 16 kcal/tsp, respectively). To capture how well diets conform to current guidance, the MPED incorporates data from a recipe file that disaggregates all foods reported in the survey to individual ingredients, and assigns those ingredients to MyPyramid groupings. For example, yogurt with fruit is separated into yogurt, fat, fruit, and energy-providing sweetener in the recipe file and assigned corresponding cup-equivalents of milk and fruit, grams of solid fat, and teaspoons of added sugar. Because MPED is currently available only through NHANES 2003-2004, energy from solid fats and added sugars were calculated for those years.

Statistical Analysis

Dietary recalls (Day 1 only) for all 2- to 18-year-olds with data deemed reliable by the study developers were included in this analysis. Appropriate weighting factors were applied to adjust for differential probabilities of selection and various sources of nonresponse. Mean intakes of total energy, energy from solid fats, and energy from added sugars were calculated. The percentage contribution and mean intake (with standard errors) of specific foods to total energy, energy from solid fats, and energy from added sugars were also estimated. Differences were examined by age (using age groups featured in current guidance [10,11]: 2 to 3, 4 to 8, 9 to 13, and 14 to 18 years old), sex, race/ethnicity (non-Hispanic whites, non-Hispanic blacks, and Mexican Americans), and family income based on the federal poverty income ratio (using three poverty income ratio categories: $\leq 130\%$ of poverty income ratio, 131% to 185%, and $>185\%$). The poverty income ratio is the ratio of income to the designated poverty threshold for the family's composition as defined by the US Census Bureau; family income $<185\%$ of poverty income ratio is considered low income and qualifies for the Special Supplemental Nutrition Program for Women, Infants, and Children and reduced-price school meals, and income $\leq 130\%$ qualifies for the Supplemental Nutrition Assistance Program (formerly the Food Stamp Program) and free school meals.

Finally, the contribution of empty calories—defined as the sum of energy from solid fats and added sugars—was calculated and put side by side with the corresponding discretionary calorie allowance for each sex–age group (11). Low activity levels were assumed because most children and adolescents do not achieve the 60 minutes/day of cardiorespiratory activity recommended in national physical activity guidelines (19). Data analyses were conducted using SAS (version 9.1.3, 2009, SAS Institute Inc, Cary, NC) and SUDAAN (version 10.0.1, 2009, Research Triangle Institute, Research Triangle Park, NC).

RESULTS

Mean intakes of energy, solid fats, and added sugars, along with the contributions (percentage and absolute intake) of specific foods contributing at least 2%, are avail-

<p>Beverages Whole milk Reduced-fat milk Skim milk Vegetable juice 100% fruit juice, not orange/grapefruit juice 100% orange/grapefruit juice Fruit drinks Soda^a Milk substitute and evaporated milk Alcoholic beverages Coffee Tea</p> <p>Bakery/breads Hot cereal Pancakes/waffles/French toast Quickbreads Cold cereals Grain desserts^b Yeast breads</p> <p>Dressings, spreads, other additions^c Butter^e Cream Margarine^{de} Mayonnaise Miscellaneous solid fats Nondairy creamer/cream substitutes Oils^d Salad dressing Sauces Sour cream Condiments Gelatins Jams and jelly Sugars/honey Syrups/toppings</p>	<p>Produce Broccoli Carrots Coleslaw Corn Fried white potatoes Lettuce Onions Other cruciferous Other white potatoes Peas Spinach String beans Sweet potatoes Tomatoes Tomato sauces Vegetable medleys and other vegetables Vegetable mixed dishes Apples and pears Avocado Bananas Citrus fruits Dried fruit Grapes Melon Peaches/plums/apricots/nectarines Strawberries Other fruit and fruit salad</p> <p>Snacks Potato/corn/other chips^d Popcorn Pretzels Nuts/seeds and nut/seed mixed dishes Candy Crackers</p>	<p>Entrees Chili Mexican mixed dishes Pizza Soups Meal replacements Pasta and pasta dishes Rice and rice mixed dishes Egg rolls</p> <p>Refrigerator/frozen Yogurt Cottage/ricotta/cream cheese Dairy desserts Frozen meals</p> <p>Deli Regular cheese Reduced fat cheese Dried beans Burgers Cold cuts Eggs and egg mixed dishes^f Tuna and tuna mixed dishes Shrimp and shrimp mixed dishes Other fish and fish mixed dishes Liver and other organ meats Beef and beef mixed dishes Chicken and chicken mixed dishes Duck and duck mixed dishes Other meat and meat mixed dishes Pork and pork mixed dishes Turkey and turkey mixed dishes Sausage, franks, bacon, and ribs Tofu and meat substitutes</p>
---	---	---

Figure 1. List of specific foods: Result of grouping like foods reported in 2003-2006 National Health and Nutrition Examination Survey. ^aIncludes sodas, energy drinks, sports drinks, and sweetened bottled waters, including vitamin waters. ^bIncludes cakes, cookies, donuts, pies, crisps, cobbler, and granola bars. ^cIncludes low-fat items such as low-fat salad dressings, cream cheese, and sour cream. ^dButter, margarine, and oils do not include those used in yeast breads, grain-based desserts, quick breads, pancakes/waffles/French toast, dairy desserts, salad dressing, mayonnaise, pasta and pasta mixed dishes, Mexican mixed dishes, ready-to-eat cereal, crackers, pretzels, potato/corn/other chips, and candy. ^eIncludes low-fat versions. ^fExcludes eggs found in grain-based desserts, pancakes/waffles/French toast, yeast breads, quick breads, dairy desserts, egg rolls, pasta, and pasta mixed dishes.

able online at <http://riskfactor.cancer.gov/diet/foodsources/energy/>. Data are provided for persons aged 2 to 18 years and by age, sex, race/ethnicity, and income level. For ease of presentation, mean intakes of energy, solid fats, and added sugars, and results from the top five sources are summarized in Tables 1 and 2 and Figure 2.

Energy

The top five sources of energy for 2- to 18-year-olds were grain desserts (cakes, cookies, donuts, pies, crisps, cobbler, and granola bars) (138 kcal/day), pizza (136 kcal/day), soda (118 kcal/day), yeast breads (114 kcal/day), and chicken and chicken mixed dishes (113 kcal/day) (Table 1). These foods each contributed >5% to energy intake, or >100 kcal/child/

day. Combining related specific foods within the beverage category, children and adolescents consumed 173 kcal from sugar-sweetened beverages (combining soda and fruit drinks) and 146 kcal from milk (combining whole and reduced-fat versions) daily (data for fruit drinks and reduced-fat milk do not always appear in the top five sources, so these data are available in online tables, see preceding paragraph for URL).

These major contributors varied by age group. For example, the top five sources of energy for 2- to 3-year-olds included whole milk (104 kcal/day), fruit juice (93 kcal/day), reduced-fat milk (91 kcal/day), and pasta and pasta dishes (86 kcal/day). Pasta and reduced-fat milk were also among the top five sources of energy for 4- to 8-year-olds (97 and 95

Table 1. Mean intake and major sources of energy, solid fats, and added sugars among children and adolescents in the United States (aged 2 to 18 years)^a

Age group	Top Five Sources														
	#1 Source	%	Mean±SE ^b (kcal)	#2 Source	%	Mean±SE (kcal)	#3 Source	%	Mean±SE (kcal)	#4 Source	%	Mean±SE (kcal)	#5 Source	%	Mean±SE (kcal)
Energy^c															
All	Grain desserts ^d	6.8	138±6.7	Pizza	6.7	136±8.5	Soda ^e	5.8	118±8.7	Yeast breads	5.6	114±6.8	Chicken ^f	5.6	113±8.1
2-3	Whole milk	7.1	104±8.2	100% fruit juice ^g	6.3	93±9.4	Reduced-fat milk	6.2	91±10.7	Pasta ^h	5.9	86±9.4	Grain desserts	4.6	68±6.6
4-8	Grain desserts	7.6	136±10.8	Yeast breads	5.4	98±5.1	Pasta	5.4	97±11.4	Reduced-fat milk	5.3	95±7.2	Pizza	5.3	95±12.3
9-13	Grain desserts	7.1	145±15.6	Pizza	6.3	128±9.5	Chicken	6.0	122±13.1	Yeast breads	5.4	109±5.8	Soda	5.2	105±12.1
14-18	Soda	9.3	226±18.2	Pizza	8.8	213±24.5	Grain desserts	6.5	157±8.4	Yeast breads	6.2	151±14.5	Chicken	5.9	143±16.6
Solid fatsⁱ															
All	Pizza	11.5	50±3.6	Grain desserts	9.8	43±2.4	Whole milk	8.2	35±3.2	Regular cheese	7.9	34±2.9	Fatty meats ^j	6.7	29±2.5
2-3	Whole milk	16.7	58±5.6	Fatty meats	11.1	39±5.0	Regular cheese	8.6	30±6.0	Reduced-fat milk	8.1	28±3.8	Grain desserts	7.2	25±2.4
4-8	Whole milk	11.3	45±5.6	Pizza	10.2	41±6.0	Grain desserts	9.0	36±2.6	Regular cheese	7.0	28±4.5	Reduced-fat milk	6.9	28±3.6
9-13	Grain desserts	11.4	51±6.0	Pizza	11.2	50±5.2	Regular cheese	8.9	40±5.3	Whole milk	6.7	30±4.4	Fatty meats	6.5	29±2.9
14-18	Pizza	14.7	70±9.3	Grain desserts	9.7	46±2.8	Regular cheese	7.6	36±3.2	Fried potatoes	6.9	33±2.3	Fatty meats	5.7	27±3.0
Added sugars^k															
All	Soda	31.8	116±5.3	Fruit drinks	15.0	55±3.1	Grain desserts	10.9	40±2.3	Dairy desserts	7.9	29±3.4	Candy	6.8	25±2.2
2-3	Fruit drinks	19.3	38±3.7	Soda	11.4	22±3.3	Grain desserts	11.3	22±1.7	Candy	8.5	17±2.5	Cold cereals	8.3	16±1.6
4-8	Soda	19.9	65±7.5	Fruit drinks	17.0	56±5.9	Grain desserts	11.2	37±2.8	Dairy desserts	10.4	34±5.9	Cold cereals	8.3	27±1.9
9-13	Soda	30.7	117±11.7	Fruit drinks	13.6	52±5.7	Grain desserts	12.4	47±5.6	Dairy desserts	8.8	33±5.2	Candy	7.8	30±3.1
14-18	Soda	44.5	197±9.7	Fruit drinks	14.1	63±5.6	Grain desserts	9.4	42±2.9	Candy	5.6	25±4.1	Dairy desserts	5.5	24±2.7

^aData source: Energy data from the National Health and Nutrition Examination Survey (NHANES) 2005-2006, solid fats and added sugars data from NHANES 2003-2004. Sample size by group from NHANES 2005-2006: ages 2-18 (n=3,778), 2-3 (n=497), 4-8 (n=899), 9-13 (n=1,047), and 14-18 (n=1,335). From NHANES 2003-2004: ages 2-18 (n=3,553), 2-3 (n=424), 4-8 (n=781), 9-13 (n=1,001), and 14-18 (n=1,347).

^bSE=standard error.

^cEnergy mean intake by group: ages 2-18 2,027 kcal, 2-3 1,471 kcal, 4-8 1,802 kcal, 9-13 2,035 kcal, and 14-18 2,427 kcal.

^dIncludes cakes, cookies, donuts, pies, crisps, cobblers, and granola bars.

^eIncludes sodas, energy drinks, sports drinks, and sweetened bottled waters, including vitamin waters.

^fIncludes chicken and chicken mixed dishes.

^gExcludes orange and grapefruit juice.

^hIncludes pasta and pasta dishes.

ⁱSolid fats mean intake by group: ages 2-18 433 kcal, 2-3 350 kcal, 4-8 401 kcal, 9-13 450 kcal, 14-18 476 kcal.

^jIncludes sausage, franks, bacon, and ribs.

^kAdded sugars mean intake by group: ages 2-18 365 kcal, 2-3 197 kcal, 4-8 329 kcal, 9-13 381 kcal, 14-18 444 kcal.

Table 2. Mean intake and major sources of energy, solid fats, and added sugars among children and adolescents in the United States (aged 2-18 years)^a, by race/ethnicity and family income

Group ^b	Top Five Sources														
	#1 Source	%	Mean±SE ^c (kcal)	#2 Source	%	Mean±SE (kcal)	#3 Source	%	Mean±SE (kcal)	#4 Source	%	Mean±SE (kcal)	#5 Source	%	Mean±SE (kcal)
Energy^d															
NHW	Grain desserts ^e	7.2	152±9.3	Pizza	7.0	148±12.8	Soda ^f	6.4	134±13.4	Yeast breads	6.1	129±10.5	Chicken ^g	5.2	109±11.3
NHB	Chicken	8.4	163±13.8	Grain desserts	6.3	123±9.3	Pizza	6.1	119±8.6	Fruit drinks	5.1	100±13.8	Pasta ^h	4.7	90±11.2
Mex-Am	Mexican dishes	7.1	136±8.5	Grain desserts	5.9	114±10.8	Pizza	5.5	105±19.2	Whole milk	5.1	99±8.3	Soda	4.8	92±4.6
≤130% PIR	Grain desserts	6.1	117±9.4	Chicken	6.0	116±13.7	Pizza	5.9	114±9.6	Soda	5.3	101±12.8	Yeast breads	5.1	99±4.7
131%-185% PIR	Pizza	10.1	203±62.7	Soda	7.0	142±48.6	Grain desserts	6.9	138±13.4	Yeast breads	6.5	131±32.7	Pasta	5.2	104±19.0
>185% PIR	Grain desserts	7.1	148±9.2	Pizza	6.5	135±12.4	Soda	5.9	122±7.8	Yeast breads	5.7	119±7.7	Chicken	5.5	114±9.0
Solid fatsⁱ															
NHW	Pizza	13.0	57±5.3	Grain desserts	9.4	41±3.5	Regular cheese	8.9	39±4.1	Reduced-fat milk	7.2	32±3.4	Whole milk	6.7	30±4.0
NHB	Pizza	11.4	49±3.2	Grain desserts	10.4	45±4.1	Fatty meats ^j	10.1	44±7.5	Whole milk	8.8	38±3.0	Fried potatoes	6.2	27±1.7
Mex-Am	Whole milk	12.0	52±4.5	Grain desserts	10.6	45±3.2	Mexican dishes	9.8	42±5.9	Pizza	8.3	36±3.9	Regular cheese	7.1	31±4.1
≤130% PIR	Whole milk	12.7	56±5.1	Pizza	10.0	44±6.9	Grain desserts	9.7	43±3.0	Fatty meats	8.4	37±5.2	Regular cheese	7.1	31±2.7
131%-185% PIR	Pizza	13.7	59±13.8	Regular cheese	10.5	46±16.7	Whole milk	9.0	39±8.8	Grain desserts	8.5	37±2.9	Fried potatoes	8.4	36±10.4
>185% PIR	Pizza	12.2	52±5.7	Grain desserts	10.2	43±3.3	Regular cheese	7.9	34±2.2	Reduced-fat milk	6.3	27±3.2	Pasta	6.3	27±3.5
Added sugars^k															
NHW	Soda	34.7	130±8.8	Fruit drinks	12.2	46±4.3	Grain desserts	10.3	39±3.2	Dairy desserts	8.4	31±4.7	Cold cereals	6.5	24±2.1
NHB	Fruit drinks	24.3	89±3.9	Soda	21.8	80±6.5	Grain desserts	12.1	45±3.7	Candy	9.4	35±4.9	Dairy desserts	7.2	26±4.4
Mex-Am	Soda	31.5	111±14.0	Fruit drinks	19.0	67±6.1	Grain desserts	11.5	40±3.0	Candy	6.1	21±2.0	Dairy desserts	5.8	20±2.4
≤130% PIR	Soda	30.4	110±6.0	Fruit drinks	15.0	54±4.2	Grain desserts	11.4	41±4.2	Cold cereals	7.7	28±2.9	Dairy desserts	7.3	27±3.4
131%-185% PIR	Soda	32.7	110±8.7	Grain desserts	12.3	41±4.9	Fruit drinks	11.9	40±6.8	Cold cereals	8.0	27±3.8	Dairy desserts	7.2	24±3.4
>185% PIR	Soda	32.6	122±9.2	Fruit drinks	15.5	58±4.4	Grain desserts	10.2	38±2.3	Dairy desserts	8.5	32±4.7	Candy	6.8	25±3.1

^aData source: Energy data from National Health and Nutrition Examination Survey (NHANES) 2005-2006, solid fats and added sugars data from NHANES 2003-2004. Sample size by group (NHANES 2005-2006): non-Hispanic whites (n=1,018), Non-Hispanic blacks (n=1,161), Mexican Americans (n=1,253), ≤130% of the poverty income ratio (PIR) (n=1,457), 131%-185% PIR (n=451), >185% PIR (n=1,707). Sample size by group (NHANES 2003-2004): non-Hispanic whites (n=980), non-Hispanic blacks (n=1,229), Mexican-Americans (n=1,062), ≤130% PIR (n=1,536), 131-185% PIR (n=465), >185% PIR (n=1,401).

^bRace/ethnicity groups being reported are: Non-Hispanic whites (NHW), non-Hispanic blacks (NHB), and Mexican Americans (Mex-Am). Family Income groups being reported on are: families with incomes ≤130% PIR, those between 131% and 185% PIR, and those >185% PIR.

^cSE=standard error.

^dEnergy mean intake by group: Non-Hispanic whites 2,101 kcal, non-Hispanic blacks 1,941 kcal, Mexican-Americans 1,930 kcal, ≤130% PIR 1,923 kcal, 131% to 185% PIR 2,009 kcal, and >185% PIR 2,087 kcal.

^eIncludes cakes, cookies, donuts, pies, crisps, cobblers, and granola bars.

^fIncludes sodas, energy drinks, sports drinks, and sweetened bottled waters, including vitamin waters.

^gIncludes chicken and chicken mixed dishes.

^hIncludes pasta and pasta dishes.

ⁱSolid fats mean intake by group: non-Hispanic whites 442 kcal, non-Hispanic blacks 433 kcal, Mexican Americans 430 kcal, ≤130% PIR 444 kcal, 131% to 185% PIR 433 kcal, >185% PIR 425 kcal.

^jIncludes sausage, franks, bacon, and ribs.

^kAdded sugars mean intake by group: non-Hispanic whites 376 kcal, non-Hispanic blacks 368 kcal, Mexican Americans 351 kcal, ≤130% PIR 361 kcal, 131% to 185% PIR 336 kcal, >185% PIR 374 kcal.

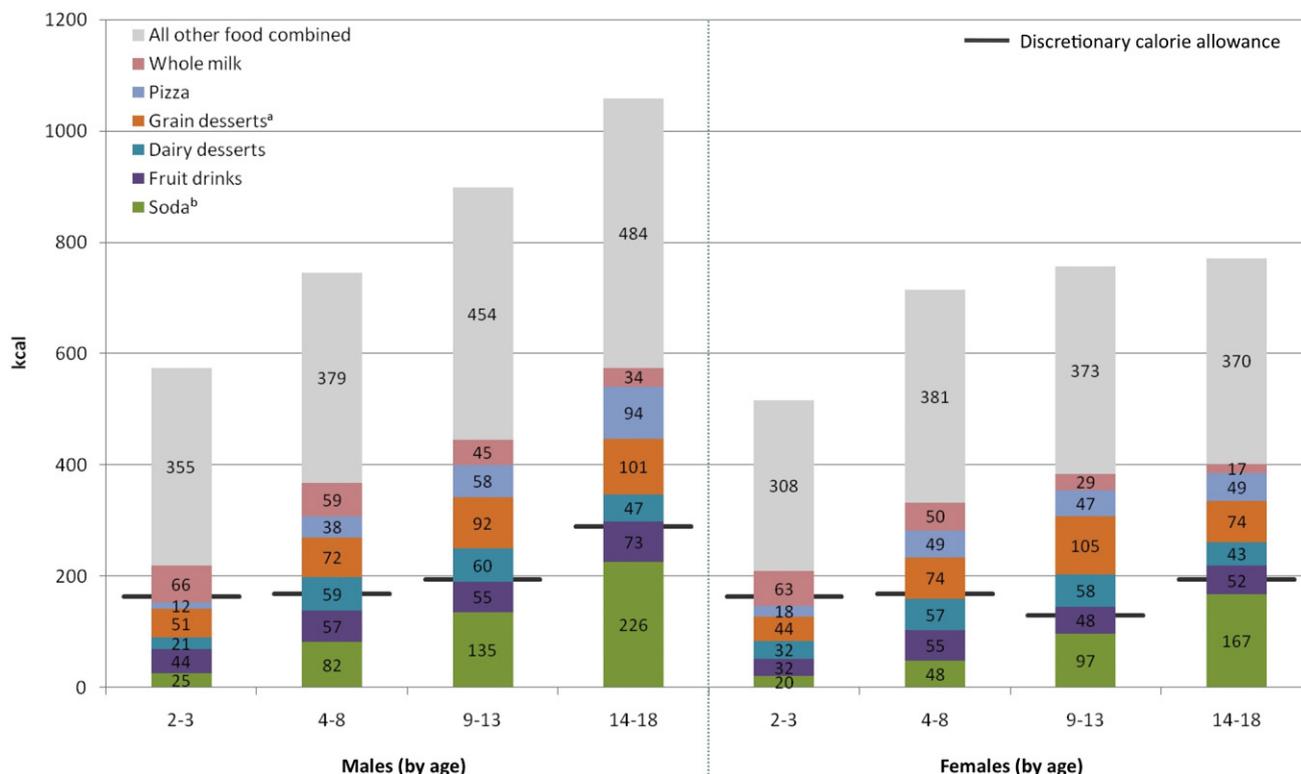


Figure 2. Food sources and mean intake of empty calories for male and female children and adolescents in the United States, relative to discretionary calorie allowance. Among 2- to 18-year-olds, about half of empty calories came from six specific foods: soda, fruit drinks, dairy desserts, grain desserts, pizza, and whole milk. The discretionary calorie allowance for each sex/age group is based on low activity levels because most children and adolescents do not achieve the 60 minutes/day of cardiorespiratory activity recommended in national physical activity guidelines (21). ^aIncludes cakes, cookies, donuts, pies, crisps, cobblers, and granola bars. ^bIncludes sodas, energy drinks, sports drinks, and sweetened bottled waters, including vitamin waters. Data Source: National Health and Nutrition Examination Survey, 2003-2004 (21). NOTE: Information from this figure is available online at www.adajournal.org as part of a PowerPoint presentation.

kcal/day, respectively). Beef was a top source for 14- to 18-year-olds (169 kcal/day) when burgers and beef and beef mixed dishes were combined (data available in online tables, see page 1479 for URL).

The top contributors of energy also varied by race/ethnicity (Table 2). For example, major contributors for 2- to 18-year-old non-Hispanic blacks included fruit drinks (100 kcal/day) and pasta and pasta dishes (90 kcal/day), whereas Mexican Americans' top sources included Mexican mixed dishes (136 kcal/day) and whole milk (99 kcal/day). Non-Hispanic blacks and whites consumed more energy from sugar-sweetened beverages (combining soda and fruit drinks) than from milk (combining all milks), whereas Mexican Americans consumed more energy from milk than from sugar-sweetened beverages (Table 2 and data available in online tables, see page 1479 for URL). The top five sources of energy by income were consistent across income levels, but varied in rank order. Beef emerged as a top source for people with a poverty income ratio <130% (102 kcal/day) when burgers and beef and beef mixed dishes were combined (data available in online tables, see page 1479 for URL).

Solid Fats

The average daily intake of energy from solid fats among 2- to 18-year-olds is 433 kcal (Table 1). The major sources of

solid fat were pizza (50 kcal/day from solid fat), grain desserts (43 kcal from solid fat), whole milk (35 kcal from solid fat), regular cheese (34 kcal from solid fat), and fatty meats (29 kcal from solid fat). This list varied by age group, with younger children obtaining a greater share of their solid fat from both whole and reduced-fat milk and 14- to 18-year-olds getting more from fried potatoes and beef (when burgers and beef and beef mixed dishes were combined). Major contributors also included fried potatoes among non-Hispanic blacks and persons with poverty income ratio between 131% and 185%, Mexican dishes among Mexican Americans, reduced-fat milk among non-Hispanic whites and persons with poverty income ratio >185%, and pasta among persons with >185% (Table 2).

Added Sugars

The average daily intake of energy from added sugars among all 2- to 18-year-olds was 365 kcal (Table 1). The major sources of added sugars were soda (116 kcal/day from added sugars), fruit drinks (55 kcal from added sugars), grain desserts (40 kcal from added sugars), dairy desserts (29 kcal from added sugars), and candy (25 kcal from added sugars). The list does not vary markedly by age and demographic groups, but cold cereals were

among the top sources for 2- to 8-year-old children, non-Hispanic whites, and low-income groups (Table 2).

Sugar-sweetened beverages (soda and fruit drinks) represented the top two sources of energy from added sugars among nearly all age and demographic groups (Tables 1 and 2). The consumption of added sugars from sugar-sweetened beverages was 60 kcal/day for 2- to 3-year-olds, 121 kcal for 4- to 8-year-olds, 169 kcal for 9- to 13-year-olds, and 260 kcal for 14- to 18-year-olds. Among all racial/ethnic and income groups, sugar-sweetened beverages contributed about 45% to 50% of added sugars. Non-Hispanic blacks obtained more added sugars from fruit drinks and less from soda than other groups.

Empty Calories

Empty calories represented the sum of energy from solid fat and added sugars. Nearly 40% of total energy consumed (798 of 2,027 kcal/day) by 2- to 18-year-olds were in the form of empty calories (433 kcal from solid fat and 365 kcal from added sugars, as shown in Table 1). This contrasts markedly with the discretionary calorie allowances, which range from 8% to 20% of total energy. As shown in Figure 2, consumption of empty calories far exceeded the corresponding discretionary calorie allowance for all sex-age groups.

Among 2- to 18-year-olds, about half of these empty calories came from six specific foods: soda, fruit drinks, dairy desserts, grain desserts, pizza, and whole milk (Figure 2). Solid fats and added sugars found in all other foods combined supplied the remainder. Sugar-sweetened beverages were the largest contributor, providing 22% of empty calories (data available in online tables, see page 1479 for URL). In fact, among both boys and girls aged 9 to 13 and 14 to 18 years, the empty calories consumed from soda and fruit drinks alone effectively used up or exceeded the discretionary calorie allowance.

DISCUSSION

To our knowledge, this is the first research to provide data on sources of solid fats and added sugars (collectively, empty calories) as well as total energy, among diets of children and adolescents, examined by race/ethnicity, income, and age groups. The variables examined are based on the most recent available data on a nationally representative sample of US children and adolescents.

Several previously published analyses laid the foundation for this work (15-18,20-24). Subar and colleagues examined data from the 1989-1991 Continuing Survey of Food Intakes by Individuals (15) and found 2- to 18-year-olds in the United States consumed 11.7% of energy from milk and 4.3% of total energy from soda (and 6.5% from all sugar-sweetened beverages). A higher proportion of energy consumption from soda and all sugar-sweetened beverages (5.8% and 8.5%, respectively) and a lower proportion of milk (7.1%) were identified in our study. These trends regarding an increase in total energy from soda and fruit drinks are consistent with previous research (23,24). More recently, Wang and colleagues (24) found that 2- to 19-year-olds consumed 10% to 15% of energy intake from sugar-sweetened beverages and 100% fruit juice. Although the food groupings and age groupings were slightly different, our

results are consistent with their findings (2- to 18-year-olds consumed 11.1% of energy intake from sugar-sweetened beverages and 100% fruit juice) (24).

A notable overlap was found between the major sources of energy and major sources of empty calories: soda, grain desserts, pizza, and whole milk. Soda is made up solely of empty calories; grain desserts can provide some nutrients but are generally rich in solid fats and added sugars; and pizza and whole milk supply needed nutrients but are also rich in solid fats. Whole milk has more nutrient-dense alternatives: fat-free milk and/or reduced-fat milk. Pizza and grain desserts are generally made commercially; these foods could benefit from reformulation to reduce the empty calories and make them healthier.

The landscape of choices available to children and adolescents must change to provide fewer unhealthy foods and more healthy foods that provide less energy. Several analyses have attempted to quantify the existing energy gap, or energy imbalance that contributes to overweight and obesity among children and adolescents (25,26). Whether the energy gap is 150 kcal/day (25) or 350 kcal/day (26), identifying sources of energy and empty calories can provide targets for changes in the marketplace and the food environment. Dietetics practitioners and other health professionals can work to promote healthier food environments for children and adolescents at multiple levels—macro, community, school, and individual levels.

Groups such as the Healthy Weight Commitment Foundation, a partnership among major food and beverage manufacturers, trade associations, retailers, and others, have formed around the common goal of reducing childhood obesity by 2015 (27). Given recent weight status trends, this is an ambitious goal, but one that the food industry is uniquely positioned to influence through the use of product innovation, portion control, and promotions. For example, a major cereal manufacturer has committed to reducing to single digits the grams of sugar per serving in sugar-sweetened breakfast cereals advertised to children (28), and other companies participating in this new initiative may consider smaller-portion packages. However, such steps will not reduce obesity if they do not significantly reduce the flow of empty calories into the nation's food supply, limit unhealthy foods, and provide consistent messaging about healthy foods. Future studies may investigate links between changes in empty calories in the food supply and changes in dietary intake.

Limitations

Several caveats are worth noting to aid in interpretation of the data. First, decisions regarding how to group or separate foods influenced the rankings. For example, fat-free milk, reduced-fat milk, and whole milk were analyzed separately, as were soda, fruit drinks, and fruit juices, to allow for meaningful differences to be seen where they existed. Although it was informative to examine these as discrete foods, it was also useful to combine them to see their additive contribution to energy intakes.

Second, the rankings for the specific foods also depended in part on how ubiquitously a given food was consumed. Foods that contained the most energy, solid fats, and added sugars were not necessarily the major contributors to population intake. Because some foods were commonly consumed in the population, they contrib-

uted more to total intake than foods that contained more energy (solid fats and added sugars) per portion. Similarly, because adolescents require and consumed more energy than smaller children, the rankings for all ages considered together were heavily influenced by those of older children and teenagers.

Third, the mean contribution represents the average per capita rather than per user. For example, all persons aged 2 to 18 years consumed an average of 118 kcal/day from soda. If the analysis was restricted to only those children and adolescents who reported drinking soda on a given day, average energy intake from soda would be higher.

Finally, these analyses make use of data from NHANES 2003-2004. Although more recent NHANES data are available, MPED updates have not kept up with NHANES releases. It is not expected that substantial shifts in sources of energy, saturated fat, or added sugars occurred in the relatively short span between these survey cycles. However, updated databases for MyPyramid equivalents are necessary to enable monitoring of trends. More current MPED data also are necessary for any other analysis requiring that food intake be evaluated in relation to dietary guidance.

CONCLUSIONS

The epidemic of obesity among children and adolescents is now widely regarded as one of the most important public health problems in the United States. Most experts agree that the solution will involve changes in both diet and physical activity to affect energy balance. For diet, this means a reduction in energy from current consumption levels. Although reduction in energy intake from any source could lead to weight change, it seems imprudent to advise children to cut down on key nutrient-bearing food groups, such as fruits, vegetables, whole grains, fat-free milk, and lean meats. This is especially true because solid fats and added sugars are consumed in amounts far in excess of allowance levels. This research identifies the major sources of overall energy and empty calories, providing context for dietary guidance that could specifically focus on limiting energy from these sources and for changes in the food environment.

STATEMENT OF POTENTIAL CONFLICT OF INTEREST: No potential conflict of interest was reported by the authors.

ACKNOWLEDGEMENTS: The authors thank Lisa Kahle, Information Management Systems, Inc, for SAS programming and data analysis; Carmita Signes, NOVA Research, for Table and Figure preparation; and Anne Rodgers for her thoughtful review.

References

- Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003-2006. *JAMA*. 2008;299:2401-2405.
- Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007-2008. *JAMA*. 2010;303:242-249.
- Dietz WH. Health consequences of obesity in youth: Childhood predictors of adult disease. *Pediatrics*. 1998;101:518-525.
- Schwimmer JB, Burwinkle TM, Varni JW. Health-related quality of life of severely obese children and adolescents. *JAMA*. 2003;289:1813-1819.
- Nielsen SJ, Siega-Riz AM, Popkin BM. Trends in energy intake in US between 1977 and 1996: Similar shifts seen across age groups. *Obesity Res*. 2002;10:370-378.

- Nielsen SJ, Popkin BM. Patterns and trends in food portion sizes, 1977-1998. *JAMA*. 2003;289:450-453.
- Brownell KD, Schwartz MB, Puhl RM, Henderson KE, Harris JL. The need for bold action to prevent adolescent obesity. *J Adolesc Health*. 2009;45:S8-S17.
- Krebs-Smith SM, Reedy J, Bosire C. Healthfulness of the U.S. food supply: Little improvement despite decades of dietary guidance. *Am J Prev Med*. 2010;38:472-477.
- Usual dietary intakes: Food intakes, US population, 2001-04. National Cancer Institute Web site. <http://riskfactor.cancer.gov/diet/usualintakes/pop/>. Accessed December 17, 2009.
- MyPyramid Web site. <http://www.mypyramid.gov>. Accessed December 17, 2009.
- Dietary Guidelines for Americans, 2005*. 6th ed. Washington DC: US Government Printing Office; 2005.
- Guenther PM, Reedy J, Krebs-Smith SM. Development of the Healthy Eating Index-2005. *J Am Diet Assoc*. 2008;108:1896-1901.
- Basiotis PP, Guenther PM, Lino M, Britten P. Americans consume too many calories from solid fat, alcohol, and added sugar. *Nutrition Insight*. June 2006. <http://www.cnpp.usda.gov/Publications/NutritionInsights/Insight33.pdf>. Accessed December 17, 2009.
- Dietary interview, NHANES 2003-2006. Public Data General Release File Documentation. National Center for Health Statistics Web site. http://www.cdc.gov/nchs/nhanes/about_nhanes.htm. Accessed December 17, 2009.
- Subar AF, Krebs-Smith SM, Cook A, Kahle LL. Dietary sources of nutrients among US children, 1989-1991. *Pediatrics*. 1998;102:913-923.
- Subar AF, Krebs-Smith SM, Cook A, Kahle LL. Dietary sources of nutrients among US adults, 1989 to 1991. *J Am Diet Assoc*. 1998;98:537-547.
- Cotton PA, Subar AF, Friday JE, Cook A. Dietary sources of nutrients among US adults, 1994 to 1996. *J Am Diet Assoc*. 2004;104:921-930.
- Bachman JL, Reedy J, Subar AF, Krebs-Smith SM. Sources of food group intakes among the US population, 2001-2002. *J Am Diet Assoc*. 2008;108:804-814.
- Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc*. 2008;40:181-188.
- Thompson FE, Dennison BA. Dietary sources of fats and cholesterol in US children aged 2 through 5 years. *Am J Public Health*. 1994;84:799-806.
- Troiano RP, Briefel RR, Carroll MD, Bialostosky K. Energy and fat intakes of children and adolescents in the United States: Data from the National Health and Nutrition Examination Surveys. *Am J Clin Nutr*. 2000;72(suppl):1343S-1353S.
- Guthrie JF, Morton JF. Food sources of added sweeteners in the diets of Americans. *J Am Diet Assoc*. 2000;100:43-51.
- Nielsen S, Popkin B. Changes in beverage intake between 1977 and 2001. *Am J Prev Med*. 2004;27:205-210.
- Wang YC, Bleich SN, Gortmaker SL. Increasing caloric contribution from sugar-sweetened beverages and 100% fruit juices among US children and adolescents, 1988-2004. *Pediatrics*. 2008;121:e1604-e1614.
- Wang YC, Gortmaker SL, Sobol AM, Kuntz KM. Estimating the energy gap among US children: A counterfactual approach. *Pediatrics*. 2006;118:e1721-e1733.
- Swinburn B, Sacks G, Ravussin E. Increased food energy supply is more than sufficient to explain the US epidemic of obesity. *Am J Clin Nutr*. 2009;90:1453-1456.
- Overview. Healthy Weight Commitment Foundation Web site. <http://www.healthyweightcommit.org/about>. Accessed December 17, 2009.
- General Mills announces plans to reduce sugar content of children's cereals. Robert Wood Johnson Foundation Web site. <http://www.rwjf.org/childhoodobesity/digest.jsp?id=26422>. Accessed December 17, 2009.

 American Dietetic Association

Evidence Analysis Library®

For additional information on this topic, visit

ADA's Evidence Analysis Library at
www.adaevidencelibrary.com