

Consumption of added sugars among US children and adults by food purchase location and food source^{1–3}

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ABSTRACT

Background: The proposed changes to the Nutrition Facts Label by the US Food and Drug Administration will include information on added sugars for the first time.

Objective: The objective was to evaluate the sources of added sugars in the diets of a representative sample of US children and adults by food purchase location and food source (eg, food group).

Design: This cross-sectional study among 31,035 children, adolescents, and adults aged ≥ 6 y from the 2003–2004, 2005–2006, 2007–2008, and 2009–2010 NHANES used data from a 24-h dietary recall to evaluate consumption of added sugars. Food locations of origin were identified as stores (supermarket or grocery store), quick-service restaurants (QSRs)/pizza, full-service restaurants (FSRs), schools, and others (eg, vending machines or gifts). Added sugars consumption by food purchase location was evaluated by age, family income-to-poverty ratio, and race-ethnicity. Food group sources of added sugars were identified by using the National Cancer Institute food categories.

Results: Added sugars accounted for $\sim 14.1\%$ of total dietary energy. Between 65% and 76% of added sugars came from stores, 6% and 12% from QSRs, and 4% and 6% from FSRs, depending on age. Older adults (aged ≥ 51 y) obtained a significantly greater proportion of added sugars from stores than did younger adults. Lower-income adults obtained a significantly greater proportion of added sugars from stores than did higher-income adults. Intake of added sugars did not vary by family income among children/adolescents. Soda and energy and sports drinks were the largest food group sources of added sugars (34.4%), followed by grain desserts (12.7%), fruit drinks (8.0%), candy (6.7%), and dairy desserts (5.6%).

Conclusions: Most added sugars came from foods obtained from stores. The proposed changes to the Nutrition Facts Label should capture the bulk of added sugars in the US food supply, which suggests that the recommended changes have the potential to reduce added sugars consumption. *Am J Clin Nutr* doi: 10.3945/ajcn.114.089458.

INTRODUCTION

Added sugars represent a significant proportion of the US diet, supplying from 13.1% to 17.5% of total daily energy among children and 11.2% to 14.5% among adults, depending on age (1, 2). There are concerns that excessive consumption of added sugars has contributed to the US obesity epidemic (3, 4). The potential links between intake of added sugars and obesity and other outcomes, including diabetes and cardiovascular disease, have become a matter of public health concern (5–9). Despite evidence of a decreasing consumption of added sugars in the

United States (10–12), reducing added sugars consumption remains a priority of the 2010 Dietary Guidelines for Americans, the WHO, American Heart Association, the Institute of Medicine, and the American Academy of Pediatrics (3, 13–16). Energy from added sugars is an important and detrimental component of the 2010 Healthy Eating Index—a measure of conformance to the 2010 Dietary Guidelines for Americans (17, 18).

According to the National Cancer Institute (NCI)⁴ analyses of NHANES 2005–2006 data, the primary sources of added sugars in the American diet were soda and energy and sports drinks, grain-based desserts, fruit drinks, dairy desserts, and candy (19). Collectively, these food groups contributed 66% of total added sugars. Whereas the principal food sources of added sugars have been well characterized, the principal purchase locations have not. A recent CDC report estimated that between 58% and 67% of added sugars consumed by adults were consumed at home as opposed to away from home (1). Data on specific purchase locations, such as supermarkets or grocery stores, quick-service restaurants (QSRs), full-service restaurants (FSRs), or school cafeterias have not been evaluated.

Because the Nutrition Facts Label applies to packaged foods, it is important to know whether the proposed changes will capture the bulk of added sugars consumed in the US. The present analyses evaluated added sugars consumption in a representative sample of US children and adults by food purchase location and specific food source (eg, food groups).

SUBJECTS AND METHODS

Dietary intake data

This cross-sectional study was based on data from 4 cycles of the nationally representative NHANES from 2003–2004,

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⁴ Abbreviations used: FNDDS, Food and Nutrition Database for Dietary Studies; FSR, full-service restaurant; IPR, income-to-poverty ratio; MPED, MyPyramid Equivalents Database; NCI, National Cancer Institute; QSR, quick-service restaurant.

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2005–2006, 2007–2008, and 2009–2010. NHANES is a large population-based survey that uses a complex multistage probability sample to create a representative sample of the non-institutionalized civilian US population. Data from a 24-h dietary recall was used to identify the primary sources of added sugars by food purchase location, and by specific food source (20). The National Center for Health Statistics obtained Institutional Review Board approval for all cycles of NHANES, and the data have been made available for public use (21). Analyses of publicly available federal data are exempt from human subject review by the University of Washington.

The current analyses were based on one 24-h dietary recall conducted in person. A single 24-h recall for a large population yields an unbiased estimate of the population-level dietary patterns (22). Respondents reported the types and amounts of all foods and beverages consumed in the preceding 24 h, from midnight to midnight. The NHANES 24-h recall, using the USDA computerized Automated Multiple Pass Method, first identified the foods consumed and followed with a probe for any forgotten foods and the reporting of time and occasion for each food item reported. A detailed cycle was then conducted to estimate amounts consumed, followed by a final probe for any potentially forgotten foods (20). For children aged 6–11 y, the child was the primary respondent, but a proxy respondent (parent or guardian) was present and able to assist. For children aged ≥ 12 y, the child was the primary source of dietary recall, but could be assisted by an adult who had knowledge of their diet. The dietary recall could be conducted in either Spanish or English.

Data from the MyPyramid Equivalents Database (MPED) were used to assess intakes of added sugars in teaspoon equivalents, which corresponds to ~ 4.2 g table sugar (23). The MPED 2.0 database was updated for use with more recent NHANES cycles by imputing the MPED equivalents for a limited number of foods ($n = 291$). Data for the more recent Food Patterns Equivalent Database were not used because this analysis was completed before the release of the database.

Purchase locations of origin

For each food or beverage listed, NHANES data provided information on the locations where the food was obtained (eg, food purchase locations). The primary locations were stores, QSRs (including pizza takeout/delivery), FSRs, and schools. The other locations of origin included food as a gift from someone else, vending machines, other types of cafeterias (including in the workplace), tavern/bar, or a sporting, cultural, or entertainment event (eg, movie theater or baseball game) (20). The store category did not separate grocery stores, supermarkets, convenience stores, and specialty food stores. For this study, the primary purchase locations were limited to grocery stores, QSRs (including pizza takeout/delivery), FSRs, school cafeterias (for children/adolescents), and a combined “other” category.

Defining food sources

The Food and Nutrient Database for Dietary Studies (FNDDS) provides a detailed description of each food and beverage consumed by NHANES participants (24). All foods consumed by NHANES participants were aggregated into 96 food groups

belonging to 8 major food groups, based on a food-coding scheme developed by the NCI. In the current study, NHANES-cycle specific versions of FNDDS were used (eg, FNDDS 2.0 for NHANES 2003–2004) (24). Examples of food groups were soda and energy and sports drinks, yeast breads, grain-based desserts, burgers, fried potatoes, pizza, sandwiches, chicken dishes, or mixed Mexican dishes. The NCI food groups have been useful for showing the relative contribution of different food groups to energy or nutrient intakes at the population level (3, 19). The authors of the current study coded the NHANES foods into the NCI food groups.

Analytic approach

Separate analyses were conducted for children (age 6–11 y), adolescents (age 12–19 y), and younger (age 20–50 y) and older (age ≥ 51 y) adults and for the entire population. These age groups were selected to focus on elementary school-age children, secondary school-age children, and younger and older adults.

First, the NCI coding scheme was used to estimate the relative contribution of specific food sources to added sugars intakes by age group. The food purchase location was then used to estimate the relative contribution of added sugars to the US diet by age group, race-ethnicity, and family income-to-poverty ratio (IPR). Age, race-ethnicity, and family income were assessed in the NHANES questionnaire. Analyses of food purchase location for added sugars by race-ethnicity and family IPR were conducted separately for children/adolescents and adults, and all analyses were age-adjusted to account for differences in the age distribution that may drive any relation between race/family income and added sugars consumption. Age adjustment was done using direct standardization with age weights from the US standard million population (25).

Whereas the primary aim of this cross-sectional study was descriptive, limited hypothesis testing was conducted. Specifically, we evaluated whether there were significant effects of age group and race-ethnicity on added sugars consumption using a survey-weighted Wald test after adjusting for age by making a pairwise contrast with age 20–50 y and non-Hispanic whites as the reference groups. Similar analyses were conducted for family IPR with 4 groups (<1 , 1–1.99, 2–3.99, and ≥ 4), the reference group being children/adolescents or adults with a ratio <1 . All analyses were based on a complete case approach, and only data for family IPR were missing for some subjects. Because NHANES is a complex sample survey, all analyses reported here were survey-weighted to account for the survey design and reflect the behaviors of the US population. Analyses were conducted by using Stata 13.1 (StataCorp).

RESULTS

Study population

Of 34,039 children and adults aged ≥ 6 y in the 2003–2010 NHANES database, 31,035 completed a valid 24-h recall (4187 children aged 6–11 y, 6698 adolescents aged 12–19 y, 10,700 adults aged 20–50 y, and 9450 adults aged >50 y). Only individuals who did not complete a valid 24-h recall were excluded from the current study. The study population was

representative of the US population from 2003 to 2010: 69% of the study population was non-Hispanic white, 12.1% was non-Hispanic black, 9.1% was Mexican-American, 4.2% was other Hispanic, and 5.7% was other race/mixed race.

Added sugars by age and food purchase location

Added sugars consumption, by age group and by purchase location, are shown in **Figure 1**. Overall, 71.1% (95% CI: 70.3%, 71.9%) of added sugars consumed among children and adults aged ≥6 y came from stores. About 15.6% (95% CI: 14.9%, 16.4%) of added sugars came from restaurants, 9.9% (95% CI: 9.3%, 10.4%) from QSRs, and 5.8% (95% CI: 5.3%, 6.2%) from FSRs. For each age group, at least two-thirds of added sugars came from stores.

For primary school-age children (6–11 y), 65.1% (95% CI: 62.9%, 67.4%) of added sugars came from grocery stores, 9.0% (95% CI: 7.8%, 10.1%) from QSRs, 4.3% (95% CI: 3.4%, 5.2%) from FSRs, and 6.8% (95% CI: 5.8%, 7.9%) from school cafeterias. Among adolescents (12–19 y), 70.3% (95% CI: 68.8%, 71.8%) of added sugars came from grocery stores, 11.6% (95% CI: 10.8%, 12.5%) from QSRs, and 4.9% (95% CI: 4.0%, 5.7%) from FSRs. The contribution of school cafeterias was 3.8% (95% CI: 3.0%, 4.6%). For adults aged 20–50 y, 70.4% (95% CI: 69.1%, 71.6%) of added sugars came from grocery stores, 11.1% (95% CI: 10.2%, 12.1%) from QSRs, and 6.1% (95% CI: 5.5%, 6.7%) from FSRs. Consumption of added sugars was lower among adults aged ≥51 y: 75.7% (95% CI: 74.5%, 76.9%) came from grocery stores, and 6.3% (95% CI: 5.6%, 7.0%) and 6.2% (95% CI: 5.5%, 6.9%) each came from QSRs and FFRs, respectively.

Added sugars by income and purchase location

Data on family IPR were missing for 6.8% of subjects (*n* = 2105), who were excluded from the analysis by IPR. Added sugars consumption among children aged 6–19 y, by IPR and by purchase location, are shown in **Figure 2** (top panel). Added sugars consumption among adults aged ≥20 y, by household

income and purchase location, are shown in **Figure 2** (bottom panel). Stores supplied the bulk of added sugars for all age and income groups. Lower-income (IPR <1.0) adults consumed significantly more added sugars and derived a significantly greater proportion of added sugars from grocery stores than did higher-income adults (IPR ≥4). No socioeconomic gradient in added sugars consumption was observed for children.

Added sugars by race-ethnicity and purchase location

Added sugars consumption among children aged 6–19 y, by race-ethnicity and by purchase location, are shown in **Figure 3** (top panel). Non-Hispanic white children consumed significantly more added sugars overall than did Mexican-American (*P* < 0.001) and non-Hispanic black (*P* = 0.04) children. Non-Hispanic white children consumed significantly more store-bought added sugars than did Mexican-American children (*P* < 0.001). Non-Hispanic white children consumed significantly more added sugars from QSRs than did non-Hispanic black

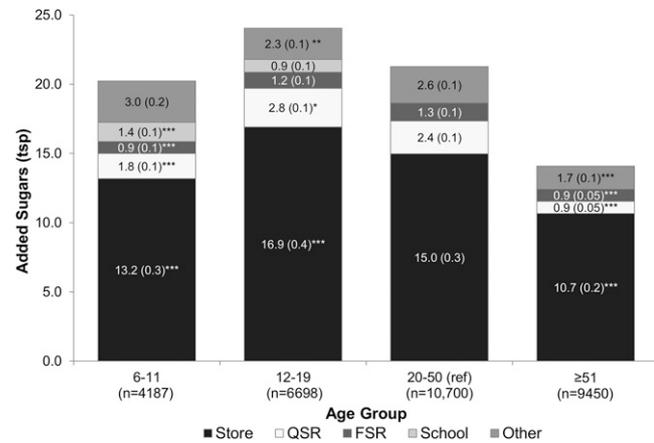


FIGURE 1. Mean added sugars (tsp equivalent) consumption by food purchase location and age group, NHANES 2003–2010. 1 tsp equivalent ~ 4.2 g table sugar (23). Values in parentheses are SEs. Asterisks indicate a statistically significant difference from the 20–50 y age group (reference group; age 12–19 y is the reference group for school data) based on a survey-weighted Wald test: ****P* < 0.001, **0.001 < *P* < 0.01, *0.01 < *P* < 0.05. FSR, full-service restaurant; QSR, quick-service restaurant; tsp, teaspoon.

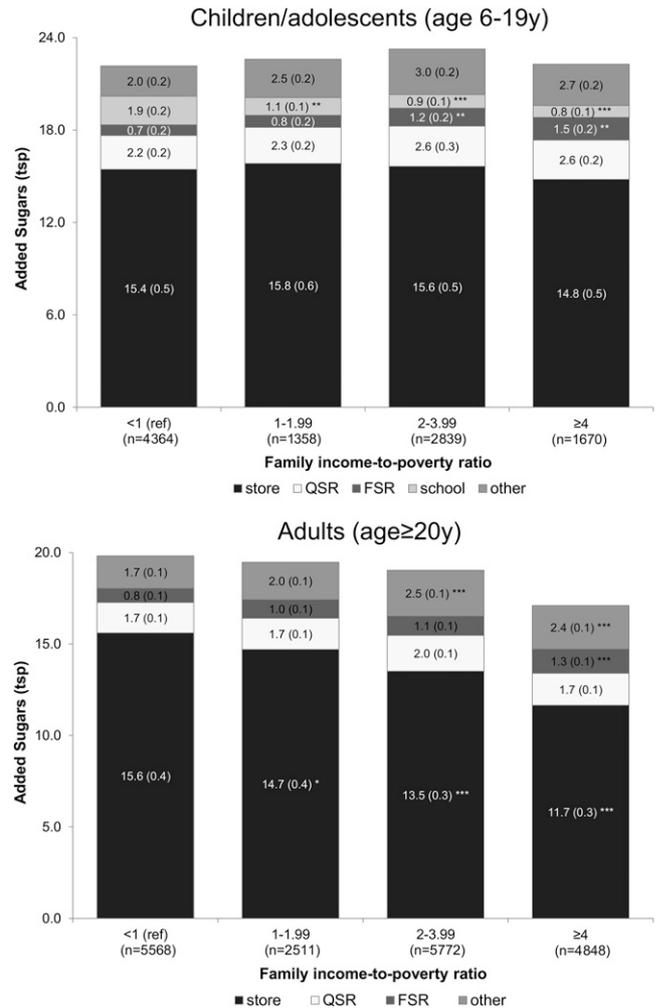


FIGURE 2. Age-adjusted mean added sugars (tsp equivalent) intake by food purchase location and family income-to-poverty ratio among US children/adolescents (age 6–19 y) and adults (age ≥ 20 y), NHANES 2003–2010. 1 tsp equivalent ~ 4.2 g table sugar (23). Values in parentheses are SEs. Asterisks indicate a statistically significant difference from the family income-to-poverty ratio < 1 (reference group) based on a survey-weighted Wald test: ****P* < 0.001, **0.001 < *P* < 0.01, *0.01 < *P* < 0.05. FSR, full-service restaurant; QSR, quick-service restaurant; tsp, teaspoon.

children ($P < 0.001$). Non-Hispanic white children consumed significantly less added sugars from schools than did either non-Hispanic black ($P < 0.001$) or Mexican-American ($P = 0.004$) children.

Added sugars consumption among adults aged ≥ 20 y, by race-ethnicity and purchase location, are shown in Figure 3 (bottom panel). The age-adjusted proportion of added sugars from stores was 72.4% (95% CI: 71.3%, 73.5%) for non-Hispanic white adults, 75.5% (95% CI: 74.0%, 77.0%) for non-Hispanic black adults, and 73.5% (95% CI: 71.1%, 75.9%) for Mexican American adults. However, the differences by race-ethnicity were the opposite of those observed for children. Non-Hispanic white adults consumed the least amount of added sugars overall, whereas non-Hispanic blacks consumed the most ($P < 0.001$ compared with non-Hispanic white adults).

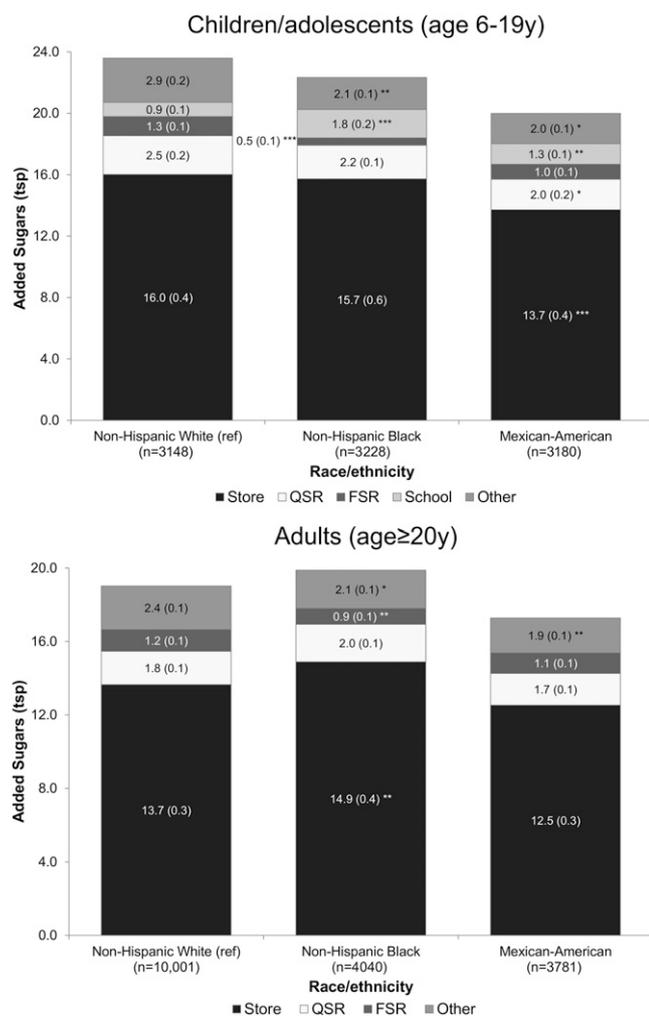


FIGURE 3. Age-adjusted mean added sugars (tsp equivalent) intake by food purchase location and race-ethnicity among US children/adolescents (age 6–19 y) and adults (age ≥ 20 y), 2003–2010. 1 tsp equivalent ~ 4.2 g table sugar (23). Values in parentheses are SEs. Asterisks indicate a statistically significant difference from non-Hispanic whites (reference group) based on a survey-weighted Wald test: *** $P < 0.001$, ** $0.001 < P < 0.01$, * $0.01 < P < 0.05$. FSR, full-service restaurant; QSR, quick-service restaurant; tsp, teaspoon.

Added sugars by specific food source

Added sugars accounted for $\sim 14.1\%$ (95% CI: 13.8%, 14.4%) of dietary energy in the total diet. The contribution of added sugars to total daily energy intakes first rose and then fell with age. Added sugars provided 16.2% (95% CI: 15.7%, 16.9%) of total dietary energy for the 6–11-y age group, 17% (95% CI: 16.4%, 17.5%) of energy for the 12–19-y age group, 14.4% (95% CI: 13.9%, 14.9%) of energy for the 20–50-y age group, and 11.6% (95% CI: 11.3%, 12.0%) for the ≥ 51 -y age group.

The main sources of added sugars in the US diet for the population aged ≥ 6 y are shown elsewhere (see Supplemental Figure 1 under “Supplemental data” in the online issue). Data are presented for the top 10 food groups. Consistent with past analyses of 2005–2006 NHANES (19), soda and energy and sports drinks were the largest single source of added sugars (34.4%), followed by grain desserts (12.7%), fruit drinks (8.0%), candy (6.7%), and dairy desserts (5.6%). All of the remaining food groups contributed 14.5% of added sugars, with no single category providing $>0.3\%$ of total. Converted to energy intakes, added sugars from soda and energy and sports drinks accounted for $\sim 4.9\%$ of total daily energy from all sources; grain deserts supplied 1.8% and fruit drinks another 1.1%.

The contribution to added sugars consumption of specific food sources is shown elsewhere (see Supplemental Table 1 under “Supplemental data” in the online issue). Added sugars from the top 20 food sources are presented in teaspoon equivalents (tsp) and are shown separately by age group. Briefly, the top sources of added sugars for children aged 6–11 y were soda and energy and sports drinks (4.7 tsp), followed by grain desserts (2.6 tsp), fruit drinks (2.5 tsp), candy (1.7 tsp), and dairy desserts (1.4 tsp). Among adolescents aged 12–19 y, the top sources were soda (10 tsp), fruit drinks (2.5 tsp), grain-based desserts (2.3 tsp), and candy (1.7 tsp). For younger adults, the leading sources were soda (8.6 tsp), grain-based desserts (2.4 tsp), fruit drinks (1.6 tsp), and candy (1.3 tsp). For older adults, the main sources were soda (3.1 tsp), grain-based desserts (2.5 tsp), dairy desserts (1.2 tsp), and candy (1.0 tsp).

Store-bought added sugars by age and specific food source

The top 20 sources of store-bought added sugars (tsp), by age group, are shown in **Table 1**. Among children aged 6–11 y, most added sugars came from store-bought soda (2.7 tsp), fruit drinks (1.9 tsp), grain-based desserts (1.8 tsp), ready-to-eat cereals (1.2 tsp), candy (1.1 tsp), and syrups/toppings (0.9 tsp). For the 12–19 y age group, most added sugars came from store-bought soda (6.6 tsp), fruit drinks (1.9 tsp), grain-based desserts (1.7 tsp), ready-to-eat cereals (1.1 tsp), and candy (1.3 tsp). For the 20–50 y age group, most added sugars came from store-bought soda (5.7 tsp), grain-based desserts (1.7 tsp), fruit drinks (1.2 tsp), and candy (1.0 tsp). For adults aged >50 y, added sugars came from store-bought soda (2.1 tsp), grain-based desserts (1.7 tsp), dairy desserts (0.9 tsp), and candy (0.9 tsp).

The top 20 food sources of added sugars (tsp) from QSRs, FSRs, and “other” sources (excluding stores and restaurants), by age group, are shown elsewhere (see Supplemental Tables 2–4 under “Supplemental data” in the online issue). Among children, adolescents, and adults aged 6–11 y, 12–19 y, and 20–50 y,

TABLE 1

Consumption of added sugars (tsp equivalents) from stores by age group and food source, NHANES 2003–2010¹

Food source ²	Age 6–11 y (n = 4187)		Age 12–19 y (n = 6698)		Age 20–50 y (n = 10,700)		Age ≥51 y (n = 9450)	
	Added sugars intake	Percentage of total added sugars	Added sugars intake	Percentage of total added sugars	Added sugars intake	Percentage of total added sugars	Added sugars intake	Percentage of total added sugars
	<i>tsp equivalent</i>	%	<i>tsp equivalent</i>	%	<i>tsp equivalent</i>	%	<i>tsp equivalent</i>	%
Soda and energy and sports drinks	2.7 ± 0.17	13 ± 0.8	6.6 ± 0.28	27 ± 0.9	5.7 ± 0.24	27 ± 0.8	2.1 ± 0.09	15 ± 0.6
Grain-based desserts	1.8 ± 0.09	8.7 ± 0.4	1.7 ± 0.06	7.2 ± 0.3	1.7 ± 0.07	8.0 ± 0.4	1.7 ± 0.07	12 ± 0.4
Fruit drinks	1.9 ± 0.10	9.6 ± 0.5	1.9 ± 0.10	8.1 ± 0.4	1.2 ± 0.06	5.8 ± 0.3	0.60 ± 0.05	4.3 ± 0.3
Candy	1.1 ± 0.09	5.7 ± 0.4	1.3 ± 0.06	5.4 ± 0.3	0.98 ± 0.05	4.6 ± 0.2	0.90 ± 0.06	6.4 ± 0.4
Dairy desserts	0.83 ± 0.06	4.1 ± 0.3	0.77 ± 0.07	3.2 ± 0.3	0.66 ± 0.04	3.1 ± 0.2	0.92 ± 0.04	6.6 ± 0.2
Tea	0.27 ± 0.04	1.4 ± 0.2	0.57 ± 0.09	2.4 ± 0.4	0.70 ± 0.07	3.3 ± 0.3	0.50 ± 0.05	3.6 ± 0.4
Ready-to-eat cereals	1.2 ± 0.06	5.8 ± 0.3	1.1 ± 0.05	4.8 ± 0.2	0.64 ± 0.03	3.0 ± 0.1	0.50 ± 0.02	3.6 ± 0.1
Sugars/honey	0.16 ± 0.02	0.8 ± 0.1	0.30 ± 0.04	1.2 ± 0.2	0.75 ± 0.03	3.5 ± 0.2	0.68 ± 0.03	4.8 ± 0.2
Yeast breads	0.41 ± 0.03	2.1 ± 0.1	0.47 ± 0.02	2.0 ± 0.1	0.44 ± 0.01	2.1 ± 0.1	0.52 ± 0.02	3.7 ± 0.2
Syrups/toppings	0.91 ± 0.11	4.5 ± 0.5	0.59 ± 0.07	2.4 ± 0.3	0.26 ± 0.02	1.2 ± 0.1	0.26 ± 0.02	1.8 ± 0.2
Reduced-fat milk	0.34 ± 0.04	1.7 ± 0.2	0.24 ± 0.03	1.0 ± 0.1	0.19 ± 0.02	0.9 ± 0.1	0.15 ± 0.03	1.0 ± 0.2
Yogurt	0.27 ± 0.04	1.4 ± 0.2	0.13 ± 0.01	0.5 ± 0.1	0.19 ± 0.02	0.9 ± 0.1	0.19 ± 0.02	1.4 ± 0.1
Quickbreads	0.07 ± 0.01	0.3 ± 0.1	0.07 ± 0.01	0.3 ± 0	0.13 ± 0.01	0.6 ± 0.1	0.13 ± 0.01	1.0 ± 0.1
Jams and jelly	0.22 ± 0.04	1.1 ± 0.2	0.15 ± 0.03	0.6 ± 0.1	0.13 ± 0.01	0.6 ± 0.1	0.14 ± 0.01	1.1 ± 0.1
Nondairy creamer/cream substitute	— ³	—	—	—	0.15 ± 0.01	0.7 ± 0.1	0.16 ± 0.01	1.1 ± 0.1
Condiments	0.07 ± 0.01	0.3 ± 0.1	0.07 ± 0.01	0.3 ± 0.1	—	—	—	—
Salad dressing	—	—	—	—	0.07 ± 0.01	0.3 ± 0.1	0.08 ± 0.01	0.6 ± 0.01
Alcoholic beverages	—	—	—	—	0.05 ± 0.01	0.3 ± 0.1	—	—
Coffee	—	—	0.06 ± 0.01	0.3 ± 0.1	0.13 ± 0.02	0.6 ± 0.1	0.06 ± 0.01	0.4 ± 0.1
Pizza	—	—	0.05 ± 0.01	0.2 ± 0.1	—	—	—	—
Other sources	0.85 ± 0.06	4.2 ± 0.3	0.65 ± 0.03	2.7 ± 0.1	0.78 ± 0.03	3.7 ± 0.2	0.94 ± 0.03	6.7 ± 0.2
Total	13.2 ± 0.3	—	16.9 ± 0.4	—	15.0 ± 0.3	—	10.7 ± 0.2	—

¹ All values are means ± SEs. 1 tsp equivalent ~ 4.2 g table sugar (23). tsp, teaspoon.

² Sorted by overall contribution of added sugars.

³ Values <0.05 tsp equivalents are not shown because of a lack of precision.

4.3%, 6.7%, and 6.1%, respectively, of total added sugars came from soda from QSRs. Foods from QSRs were not important sources of added sugars consumed by older adults (see Supplemental Table 2 under “Supplemental data” in the online issue). For no age groups did any single food from FSRs contribute >3% of total added sugars (see Supplemental Table 3 under “Supplemental data” in the online issue). Soda consumed from “other” sources contributed 0.74 tsp added sugars/d (3.7% of total added sugars) for the 6–11-y age group, 1.1 tsp (4.5%) for the 12–19-y age group, 0.99 tsp (4.7%) for the 20–50-y age group, and 0.26 tsp (1.8%) for the >50-y age group. Grain-based desserts were also important contributors to added sugars in the other category (see Supplemental Table 4 under “Supplemental data” in the online issue).

DISCUSSION

The current analyses provide the first detailed look at added sugars consumption in the United States by purchase location, age group, sociodemographic factors, and specific food sources. It is clear that the bulk of added sugars in the American diet came from foods and beverages purchased in stores, including supermarkets, grocery stores, and convenience stores. Store-bought added sugars accounted for 65% to 75% of added sugars consumed, depending on age. Store-bought packaged foods will generally carry the Nutrition Facts Label.

The US Food and Drug Administration has proposed a redesign of the Nutrition Facts Label for packaged foods, which will

highlight calories, portion sizes, and added sugars (26). According to the USDA MPED documentation, added sugars include all sugars used as ingredients in processed and prepared foods (23). Frequently used added sugars include white sugar, brown sugar, corn syrup, high-fructose corn syrup, molasses, maple syrup, and honey. Information on the presence of added sugars in packaged foods has not been available on the Nutrition Facts Label, which requires consumers to review the list of food ingredients to determine whether the food contains added sugars. Information on the amount of added sugars in foods has not been available (27).

The current findings suggest that these proposed US Food and Drug Administration initiatives will capture the bulk of added sugars consumed by American children and adults, negating the need for consumers to first review the total sugars content and then review the ingredients list—a frequently recommended approach (28, 29). Store-bought foods accounted for the greatest proportion of added sugars for all population groups examined, which suggests that the addition of added sugars to the Nutrition Facts Label may have the intended effect. Sixty-two percent of adults reported using the Nutrition Facts Label, and 52% reported using the ingredients list (30). The addition of added sugars information to the Nutrition Facts Label is unlikely to provide a benefit for the 38% of adults not reviewing the label. An additional benefit of revisions to the Nutrition Facts Label may be the potential reformulation of foods, an expected benefit of revisions to the label after inclusion of information on *trans* fatty acids (31).

In contrast, the total amount of added sugars from restaurants, school cafeterias, and other sources was considerably lower. For example, the amount of added sugars contributed by school meals among the 12–19-y age group was 0.9 tsp/d, or ~14.4 kcal/d. When restricted to Monday–Friday recalls alone, the amount of added sugars consumed was 1.3 tsp (or 20.0 kcal/d).

The current analyses of store-bought added sugars by socio-demographic variables are novel. First, the consumption of added sugars among adults varied inversely with incomes and was highest in lower-income groups, consistent with prior research (32). The consumption of store-bought added sugars among adults was highest among lower-income groups. These data are consistent with prior observations that diets higher in added sugars are associated with lower per calorie diet costs (33, 34). On the other hand, the consumption of added sugars among children/adolescents appeared to be independent of socioeconomic status, as measured by family income. Many factors likely contributed to the differences in the social gradient, but an innate preference for sweet foods/beverages among children is a potential upstream cause (35). Second, non-Hispanic white children aged 6–19 y consumed more added sugars than did Mexican-American children. In contrast, non-Hispanic black adults consumed significantly more added sugars than did non-Hispanic whites. The relation between added sugars and income and race-ethnicity appears to vary by age group—an observation that merits additional inquiry.

The current analyses suggest that the proportion of added sugars from stores may exceed the proportion of dietary energy from stores. Previous analyses, also based on NHANES data, have estimated store-bought calories at ~63% of total daily energy intakes (36). In contrast, the proportion of added sugars was ~71%.

It is worth noting that, whereas soda and energy and sports drinks was clearly the largest single source of added sugars for every age group, it was not the top source of calories in the US diet. Added sugars from all sources accounted for ~14.1% of total dietary energy on average. Previous estimates by the NCI have placed the energy contribution of soda and energy and sports drinks at ~5.5% of total energy (19). Previous estimates based on 2003–2008 data have shown that the energy contribution of soda and energy and sports drinks was dependent on age, varying between 3% and 8.2% (36).

The current study had some limitations. First, it was based on a single 24-h dietary recall, which may have resulted in underreporting of some foods. On average, individuals tend to underreport the consumption of foods perceived to be less healthful by underestimating amounts eaten or omitting them altogether (37, 38). This systematic underreporting may result in a falsely minimized estimation of added sugars consumption. The use of proxy respondents for younger children may result in underreporting of foods consumed while the parent is not present. The NHANES coding of food purchase location makes no distinction between supermarkets/grocery stores and convenience stores or pharmacies (20). Furthermore, evaluating the contribution of school meals to added sugars is hindered by the lack of information on season or month of data collection. Finally, the current analyses were based on purchase location as opposed to eating location.

In conclusion, the current analysis provides the first detailed look at the purchase locations for added sugars in the United

States. A large majority of added sugars consumed by Americans of all ages came from stores, including grocery stores, supermarkets, convenience stores, and pharmacies. Given the current focus on adding information on added sugars to the Nutrition Facts Label, understanding the context of added sugars consumption may help shape national policies aimed at improving the American diet.

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