

ORIGINAL ARTICLE

Children and Adolescents' Choices of Foods and Beverages High in Added Sugars Are Associated With Intakes of Key Nutrients and Food Groups

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Purpose: To determine associations between intakes of the primary food and beverage sources of added sugars and intakes of key nutrients and food pyramid groups among U.S. children aged 6–17 years.

Methods: The 1994–96 and 1998 U.S. Department of Agriculture (USDA) Continuing Survey of Food Intakes by Individuals (CSFII) were used to examine the diets of U.S. children aged 6–17 years, who provided 2 full days of dietary data. The nationally representative sample (n = 3038) included children age 6–11 (n = 1913) and adolescents age 12–17 (n = 1125). Food codes for sweetened foods and beverages were selected from the USDA Food Coding Scheme and categorized into five food and beverage categories. The Statistical Analysis System software program was used to recode and format the data for statistical analysis and the Survey Data Analysis System was used to apply sample weights and generate statistical procedures.

Results: The consumption of sweetened dairy products was positively associated with calcium intakes for children and adolescents. Consumption of presweetened cereals increased the likelihood of the children and adolescents meeting recommendations for the essential shortfall micronutrients calcium, folate, and iron, whereas the consumption of sugar-sweetened beverages, sugars and sweets, and sweetened grains decreased the

likelihood of meeting the Dietary Reference Intakes (DRI) for these nutrients. Only children who were non-consumers of sugar-sweetened beverages had a mean calcium intake that met the adequate intakes (AI). Consumption of sweetened dairy products and presweetened cereals was positively associated with the number of dairy servings consumed per day for both age groups.

Conclusions: On average, consumption of sweetened dairy foods and beverages and presweetened cereals had a positive impact on children and adolescents' diet quality, whereas sugar-sweetened beverages, sugars and sweets, and sweetened grains had a negative impact on their diet quality. © Society for Adolescent Medicine, 2004

KEY WORDS:

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Consumption of added sugars has increased dramatically in the United States [1]. Teens consume more added sugars as a percentage of total energy than any other age group. On average, intakes of added sugars contribute 20% of total energy intake for male and female adolescents. Children aged 6–11 years follow a close second with added sugars contributing nearly 19% of total energy [2]. Added sugars are sugars and sweeteners (white, brown, and raw sugars; fructose, honey, molasses, anhydrous dextrose, crystal dextrose) and syrups (corn, maple, high-fructose corn, malt, pancake) that are eaten separately or used as ingredients in processed and pre-

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pared foods [3]. Sugars present in milk and fruit, such as lactose and fructose, are not considered added sugars [3]. Major sources of added sugars in the diets of U.S. children ages 6–17 are nondiet soft drinks, fruitade drinks, sugars and sweets, sweetened grains, sweetened dairy products, and pre-sweetened cereals [2]. Together these contribute 90% of children and adolescents' total added sugars intake. Nondiet soft drinks contribute the greatest percentage of added sugars to the diets of children; 22% for children ages 6–11 and 37% and 41% for adolescent females and males, respectively [2].

Much of the change in children and adolescents' added sugar intakes can be attributed to changes in their beverage consumption patterns. As children progressed from childhood to early adolescence both the prevalence and frequency of milk and fruit juice intake decreased, whereas soft drink intakes more than tripled [4]. Paralleling that beverage pattern, nationwide surveys conducted over the past several years have established that soft drink consumption among children [5] and adolescents [6] has escalated, while at the same time, milk consumption has declined [5,6]. Children are now consuming more soft drinks, fruit drinks, and fruit juice at mealtime in place of milk [5].

Researchers [7–9] examined data from the USDA 1994, 1995, and 1996 Continuing Survey of Food Intakes by Individuals (CSFII) and determined that Americans with high intakes of added sugars have lower intakes of essential micronutrients. Forshee and Storey [10] also used the CSFII 1994–96 database to determine the impact of added sugars on the diet quality of children and adolescents. Their research design incorporated added sugars, carbohydrates minus added sugars, protein, fat, alcohol, age, and gender as independent variables in a multivariate regression model. Added sugars were positively associated with servings of grains and lean meat as well as the percentage of the Recommended Dietary Allowance (RDA) of vitamin C, iron, and folate. In contrast, added sugars were negatively associated with servings of vegetables, fruit, and dairy, as well as the percentage of the RDA of vitamin A and calcium. However, the authors believed these associations were small from a practical perspective. Furthermore, high consumption of nondiet soft drinks [8,9] has been found to have a dilutional effect on children's essential micronutrient intake.

Children and adolescents with poor diet quality may be at risk for a multitude of health problems such as obesity, heart disease, and osteoporosis, as well as other chronic diseases that occur later in life

[11]. The association between poor diet quality and the increased incidence of childhood obesity, however, is by far the most emergent concern. Over the past three decades the prevalence of overweight has tripled among U.S. children ages 6–11 and adolescents (4% to 15%, and 5% to 16%, respectively) [12]. Recent research has associated the consumption of sugar-sweetened beverages with the increased risk of childhood obesity [13].

Food and beverages, such as sweetened beverages and desserts, which are the major sources of added sugars in the American diet, tend to have a low nutrient density (ratio of nutrients to energy content) [2]. Conversely, food and beverages that are major sources of naturally occurring sugars, such as milk and fruits, tend to have a high nutrient density. This is the first study, to our knowledge, that examined the association between intakes of key nutrients and food groups by all the major food and beverage sources of added sugars using the CSFII 1994–96 and 1998 surveys.

Methods

The sample included children aged 6–11 years ($n = 1913$) and adolescents ages 12–17 ($n = 1125$) who participated in the 1994–96 and 1998 CSFII and had 2 complete days of dietary recalls. The sample design for the 1994–96 CSFII included a nationally representative sample of all people living in U.S. households, whereas the sample design for the 1998 CSFII was developed to obtain a nationally representative sample of U.S. children birth through 9 years. Trained interviewers collected data during an in-person interview, on 2 nonconsecutive days, using the multiple-pass 24-hour dietary recall method. Methods for sample selection, data collection, data file preparation, and weighting in the 1998 CSFII were modeled after the methods used in the 1994–96 CSFII, allowing for the data from the surveys to be merged [14]. Data from these CSFII surveys provide the most current information available on food consumption patterns of the U.S. population [14]. The response rate for the 1994–96 and 1998 CSFII for Day 1 was 80% and for Day 2 was 76% [14]. These response rates are acceptable for nationwide surveys and provided results that can be generalized to the U.S. population [15].

This study received an exemption from the University of Vermont Institutional Review Board for the use of human subjects, as it was a secondary data analysis.

Table 1. Sugar-sweetened Food and Beverage Categories

Sugar-sweetened food and beverage category	Foods and beverages
Sugar-sweetened beverages	Nondiet soft drinks, nondiet fruit drinks/ades, and lemonade
Sugars and Sweets	White, brown, and raw sugars, edible syrups, molasses, jellies, sweetened toppings, nondiet gelatins, and candies
Sweetened grains	Cakes, cookies, pies, cobblers, doughnuts, sweetened granola bars, breakfast bars, sweetened waffles and pancakes
Sweetened dairy products	Flavored milks, flavored yogurts, ice creams, and puddings
Presweetened cereals	Ready-to-eat sweetened cereals

Independent Study Variables

Five food and beverage categories were identified as the major sources of added sugars in the diets of U.S. children and adolescents based on Guthrie and Morton's research [2]. These included: sugar-sweetened beverages, sugars and sweets, sweetened grains, sweetened dairy, and presweetened cereals. Table 1 includes the specific foods and beverages included in each category. USDA food and beverage codes for sugar-sweetened beverages, sugars and sweets, sweetened grains, and sweetened dairy were included if the added sugar content was greater than 1 teaspoon per 100 grams. This allowed for the exclusion of foods and beverages containing nonnutritive sweeteners. Presweetened cereals were included if the added sugar content was more than 5 teaspoons per 100 grams of dry cereal (4 grams of added sugars per teaspoon). This cut-off was based on the exclusion criteria for cereals established by the Federal Supplemental Food and Nutrition Education Program for Women, Infants, and Children (WIC). The WIC program excludes a cereal if it exceeds 21.2 grams of sugar per 100 grams or not more than 6 grams of sugar per ounce of dry cereal [16]. For each of the five food and beverage categories, the mean intake in grams, the range of intake, and the approximate quartiles of intake were calculated for children aged 6–11 years and adolescents 12–17. Quartiles of intake in grams were adjusted to the nearest equivalent unit of measure to reflect the sample's food and beverage intake patterns. To estimate consumption

of added sugars for each food and beverage category, the standard units of measure were established for: (a) nonconsumers, (b) low consumers, (c) moderate consumers, and (d) high consumers.

Dependent Study Variables

Intakes of nutrients and food groups most likely to be problematic in U.S. children's diets were identified. The following measures of nutrient and food group intakes were calculated: (a) mean percent of the age- and gender-specific intakes for the percent Dietary Reference Intakes (DRI) for calcium expressed as adequate intakes (AI), folate (RDA), and iron (RDA) [17]; (b) mean intakes for saturated fat (gms), fiber (gms), and added sugars (gms); (c) mean intakes for the number of pyramid servings for the fruit, vegetable, and dairy groups [18].

Statistical Analyses

The Statistical Export and Tabulation System (SETS) output the CSFII data into a usable format. The Statistical Analysis System (SAS) was used to recode and format the data for statistical analysis. The Survey Data Analysis System (SUDAAN) was used to weight the sample, compute variances, and run the statistical procedures. Statistical significance for all analyses was set at $p < .05$. The associations among each independent variable (sugar-sweetened beverages, sugars and sweets, sweetened grains, sweetened dairy products, and presweetened ready-to-eat cereals), and the measures of nutrient and food group intakes (the percent DRI of calcium, folate, and iron; intakes of saturated fat, fiber, and added sugars; and the number of fruit, vegetable, and dairy servings) were determined using Analysis of Covariance (ANCOVA). Each statistical test was examined independent of the others to guard against Type II errors. Age, gender, race, and total energy intake were entered as control variables to adjust for differences in the dependent variables that may have been attributed to them.

Results

The final sample consisted of 3038 children and adolescents aged 6 to 17 years, and was representative of the U.S. population, with relatively equal numbers of males and females. Tables 2–6 summarize the multivariate associations among the selected

Table 2. Measures of Diet Quality by Consumption Level of Sugar-Sweetened Beverages¹

	Children 6–11 Years				Adolescents 12–17 Years			
	Non (n = 351)	Low > 0 < 240 g (n = 546)	Moderate > 240 < 480 g (n = 476)	High > 480 g (n = 523)	Non (n = 140)	Low > 0 < 360 g (n = 266)	Moderate > 360 < 720 g (n = 362)	High > 720 g (n = 357)
Calcium (% AI)	107 ^a	94 ^b	89 ^c	75 ^d	89 ^a	82 ^b	73 ^c	60 ^d
Folate (% DRI)	122 ^a	114 ^a	111 ^a	95 ^b	86 ^a	82 ^a	73 ^b	60 ^c
Iron (% DRI)	183 ^a	169 ^b	166 ^b	147 ^c	174 ^a	165 ^{a,b}	156 ^b	136 ^c
Sat fat (g)	10.3 ^a	10.8 ^a	11.9 ^b	13.6 ^c	11.3 ^a	10.5 ^a	12.3 ^b	14.3 ^c
Fiber (g)	14.1 ^a	13.4 ^a	12.6 ^b	11.0 ^c	17.0 ^a	15.5 ^b	14.6 ^b	12.8 ^c
Added sugars (g)	58 ^a	75 ^b	93 ^c	122 ^d	73 ^a	85 ^b	114 ^c	159 ^d
Fruit (serv)	1.9 ^a	1.7 ^a	1.4 ^b	1.3 ^b	1.9 ^a	1.6 ^{a,b}	1.4 ^b	1.0 ^c
Vegetable (serv)	2.2 ^{a,b}	2.1 ^{a,b}	2.3 ^b	2.0 ^a	3.3 ^a	3.0 ^a	3.0 ^a	3.0 ^a
Dairy (serv)	2.6 ^a	2.2 ^b	2.0 ^c	1.6 ^d	2.7 ^a	2.4 ^a	2.1 ^b	1.5 ^c

¹ Sugar-Sweetened Beverages include: nondiet soft drinks, nondiet fruit drinks/ades, lemonade. Measures are per day, for children 6–11 years (n = 1913) and adolescents 12–17 years (n = 1125) adjusted for age, race, gender, and total energy intake.

^{a,b,c,d} Means in a row with different superscripts are significantly different ($p < .05$).

food and beverage categories and the nutrient and food group measures.

Calcium

There was a meaningful and significant decline in calcium intakes as the consumption of sugar-sweetened beverages increased in children (6–11 years) and adolescents (12–17 years). Conversely, as the consumption of sweetened dairy products and presweetened cereals increased, calcium intakes increased significantly. Only children aged 6–11 years who were nonconsumers of sugar-sweetened beverages had a mean calcium intake that exceeded the AI. None of the other groups had a mean calcium intake that met or exceeded the AI.

Folate

Among the 6–11-year-olds, the mean intake for all consumption groups met the DRI for folate except for nonconsumers of presweetened cereals and high consumers of sugar-sweetened beverages and sugars and sweets. None of the adolescent consumption groups met the DRI for folate except high consumers of presweetened cereals.

Iron

All groups had mean iron intakes that met the DRI for iron, however, iron intakes consistently fell as the consumption of sugar-sweetened beverages, sugars and sweets, and sweetened grains increased. For

Table 3. Measures of Diet Quality by Consumption Level of Sugars and Sweets¹

	Children 6–11 Years				Adolescents 12–17 Years			
	Non (n = 413)	Low > 0 < 15 g (n = 466)	Moderate > 15 < 60 g (n = 639)	High > 60 g (n = 395)	Non (n = 400)	Low > 0 < 15 g (n = 214)	Moderate > 15 < 45 g (n = 242)	High > 45 g (n = 269)
Calcium (% AI)	96 ^a	92 ^{a,b}	89 ^b	88 ^b	73 ^a	75 ^a	72 ^a	72 ^a
Folate (% DRI)	118 ^a	114 ^a	111 ^a	98 ^b	74 ^a	76 ^a	76 ^a	66 ^b
Iron (% DRI)	175 ^a	171 ^a	165 ^{a,b}	152 ^b	155 ^a	166 ^b	162 ^{a,b}	135 ^c
Sat fat (g)	10.4 ^a	10.8 ^a	12.5 ^b	12.7 ^b	12.1 ^a	11.9 ^a	12.9 ^a	12.9 ^a
Fiber (g)	13.2 ^a	13.2 ^a	12.9 ^a	11.3 ^b	14.6 ^a	15.3 ^a	14.7 ^a	13.8 ^a
Added sugars (g)	73 ^a	75 ^a	89 ^b	115 ^c	102 ^a	105 ^a	118 ^b	147 ^c
Fruit (serv)	1.4 ^a	1.6 ^a	1.6 ^a	1.6 ^a	1.4 ^a	1.3 ^a	1.5 ^a	1.3 ^a
Vegetable (serv)	2.3 ^a	2.3 ^a	2.2 ^a	1.8 ^b	3.3 ^a	3.3 ^a	2.9 ^{a,b}	2.6 ^b
Dairy (serv)	2.2 ^a	2.1 ^{a,b}	2.0 ^b	2.0 ^b	2.0 ^a	2.1 ^a	2.0 ^a	2.0 ^a

¹ Sugars and Sweets include: white, brown and raw sugars, edible syrups, molasses, jellies, sweetened toppings, nondiet gelatins, and candies. Measures are per day, for children 6–11 years (n = 1913) and adolescents 12–17 years (n = 1125) adjusted for age, race, gender, and total energy intake.

^{a,b,c} Means in a row with different superscripts are significantly different ($p < .05$).

Table 4. Measures of Diet Quality by Consumption Level of Sweetened Grains¹

	Children 6–11 Years				Adolescents 12–17 Years			
	Non (n = 602)	Low > 0 < 30 g (n = 493)	Moderate > 30 < 60 g (n = 377)	High > 60 g (n = 441)	Non (n = 477)	Low > 0 < 30 g (n = 188)	Moderate > 30 < 60 g (n = 183)	High > 60 g (n = 277)
Calcium (% AI)	94 ^a	93 ^a	89 ^{a,b}	86 ^b	75 ^a	78 ^a	72 ^{a,b}	67 ^b
Folate (% DRI)	116 ^a	109 ^{a,b}	112 ^{a,b}	104 ^b	74 ^a	77 ^a	76 ^a	66 ^b
Iron (% DRI)	176 ^a	165 ^{a,b}	163 ^{a,b}	159 ^b	156 ^{a,b}	161 ^a	152 ^{a,b}	147 ^b
Sat fat (g)	10.6 ^a	11.2 ^a	12.2 ^b	12.9 ^b	11.7 ^a	12.1 ^{a,b}	13.0 ^{a,b}	13.5 ^b
Fiber (g)	13.2 ^a	12.9 ^a	12.8 ^{a,b}	12.1 ^b	14.9 ^a	14.8 ^a	15.4 ^a	13.3 ^b
Added sugars (g)	81 ^a	85 ^{a,b}	87 ^b	100 ^c	109 ^a	105 ^a	120 ^b	135 ^c
Fruit (serv)	1.6 ^a	1.6 ^a	1.5 ^a	1.5 ^a	1.5 ^a	1.3 ^a	1.5 ^a	1.2 ^a
Vegetable (serv)	2.2 ^a	2.2 ^a	2.1 ^a	2.0 ^a	3.2 ^a	3.2 ^a	3.0 ^{a,b}	2.7 ^b
Dairy (serv)	2.2 ^a	2.1 ^a	2.1 ^a	1.9 ^b	2.1 ^a	2.3 ^a	2.0 ^{a,b}	1.8 ^b

¹ Sweetened grains include: cakes, cookies, pies, cobblers, doughnuts, sweetened granola bars, breakfast bars, sweetened waffles and pancakes. Measures are per day, for children 6–11 years (n = 1913) and adolescents 12–17 years (n = 1125) adjusted for age, race, gender, and total energy intake.

^{a,b,c} Means in a row with different superscripts are significantly different ($p < .05$).

both age groups, intakes of iron significantly increased as presweetened cereal intake increased.

Saturated Fat

Saturated fat consumption increased as intake of sugar-sweetened beverages, sugars and sweets, and sweetened grains increased among children. For adolescents, saturated fat consumption increased as intakes of sugar-sweetened beverages and sweetened grains increased. As intakes of sweetened dairy products increased, saturated fat intake decreased among children and adolescents.

Fiber

Intakes of fiber consistently decreased for children as intakes of sugar-sweetened beverages, sugars and

sweets, and sweetened grains increased. Among the adolescents, intakes of fiber decreased as consumption of sugar-sweetened beverages and sweetened grains increased. Conversely, fiber intakes increased as sweetened dairy products and presweetened cereal consumption increased.

Added Sugars

Mean intakes of total added sugars increased when children aged 6–11 years consumed presweetened cereals and sweetened dairy products. Among the adolescents there were no associations between sweetened dairy products and presweetened cereals and total added sugars intake. Total added sugars intake increased significantly for both age groups as

Table 5. Measures of Diet Quality by Consumption Level of Sweetened Dairy Products¹

	Children 6–11 Years				Adolescents 12–17 Years			
	Non (n = 807)	Low > 0 < 90 g (n = 339)	Moderate > 90 < 180 g (n = 412)	High > 180 g (n = 335)	Non (n = 655)	Low > 0 < 120 g (n = 156)	Moderate > 120 < 240 g (n = 195)	High > 240 g (n = 119)
Calcium (% AI)	87 ^a	87 ^a	94 ^b	99 ^c	70 ^a	70 ^a	79 ^b	85 ^b
Folate (% DRI)	115 ^a	107 ^b	112 ^a	101 ^c	72 ^a	74 ^a	74 ^a	73 ^a
Iron (% DRI)	173 ^a	158 ^b	164 ^{a,b}	161 ^{a,b}	153 ^a	156 ^a	153 ^a	160 ^a
Sat fat (g)	12.3 ^a	11.8 ^{a,b}	11.3 ^{b,c}	10.4 ^c	13.2 ^a	11.8 ^b	11.3 ^b	10.7 ^b
Fiber (g)	13.0 ^a	12.2 ^b	12.8 ^{a,b}	12.7 ^{a,b}	14.4 ^a	14.2 ^a	14.5 ^a	16.0 ^b
Added sugars (g)	81 ^a	93 ^b	92 ^b	93 ^b	115 ^a	118 ^a	120 ^a	116 ^a
Fruit (serv)	1.5 ^a	1.6 ^a	1.6 ^a	1.5 ^a	1.4 ^a	1.5 ^a	1.3 ^a	1.2 ^a
Vegetable (serv)	2.2 ^a	2.1 ^a	2.2 ^a	2.1 ^a	3.0 ^a	3.1 ^a	2.9 ^a	3.1 ^a
Dairy (serv)	1.9 ^a	2.0 ^{a,b}	2.1 ^b	2.4 ^c	1.9 ^a	1.9 ^a	2.3 ^b	2.6 ^b

¹ Sweetened Dairy Products include: flavored milks, flavored yogurts, ice creams, and puddings. Measures are per day, for children 6–11 years (n = 1913) and adolescents 12–17 years (n = 1125) adjusted for age, race, gender, and total energy intake.

^{a,b,c} Means in a row with different superscripts are significantly different ($p < .05$).

Table 6. Measures of Diet Quality by Consumption Level of Presweetened Cereals¹

	Children 6–11 Years				Adolescents 12–17 Years			
	Non (n = 1021)	Low > 0 < 15 g (n = 106)	Moderate > 15 < 30 g (n = 353)	High > 30 g (n = 433)	Non (n = 772)	Low > 0 < 30 g (n = 118)	Moderate > 30 < 45 g (n = 117)	High > 45 g (n = 118)
Calcium (% AI)	89 ^a	87 ^{a,b}	92 ^{a,b}	95 ^b	69 ^a	76 ^b	77 ^b	89 ^c
Folate (% DRI)	95 ^a	100 ^a	114 ^b	145 ^c	62 ^a	76 ^b	89 ^c	118 ^d
Iron (% DRI)	155 ^a	164 ^a	161 ^a	197 ^b	141 ^a	150 ^b	168 ^c	222 ^d
Sat fat (g)	11.3 ^a	12.2 ^{a,b}	11.5 ^a	12.4 ^b	12.1 ^a	13.1 ^a	12.8 ^a	13.5 ^a
Fiber (g)	13.0 ^a	12.1 ^a	12.5 ^a	12.6 ^a	14.4 ^a	13.8 ^a	13.8 ^a	16.6 ^b
Added sugars (g)	83 ^a	99 ^b	94 ^b	93 ^b	116 ^a	120 ^a	119 ^a	114 ^a
Fruit (serv)	1.6 ^a	1.6 ^a	1.5 ^a	1.5 ^a	1.4 ^a	1.3 ^a	1.5 ^a	1.6 ^a
Vegetable (serv)	2.2 ^a	1.8 ^b	2.1 ^{a,b}	2.1 ^{a,b}	3.2 ^a	3.2 ^a	2.8 ^{a,b}	2.3 ^b
Dairy (serv)	2.0 ^a	2.0 ^{a,b}	2.1 ^{b,c}	2.3 ^c	1.9 ^a	2.1 ^b	2.3 ^{b,c}	2.7 ^c

¹ Presweetened cereals include: ready-to-eat presweetened cereals. Measures are per day, for children 6–11 years (n = 1913) and adolescents 12–17 years (n = 1125) adjusted for age, race, gender, and total energy intake.

^{a,b,c,d} Means in a row with different superscripts are significantly different ($p < .05$).

intakes of sugar-sweetened beverages, sugars and sweets, and sweetened grains increased.

Fruit, Vegetable, and Dairy Servings

The number of fruit servings decreased as intakes of sugar-sweetened beverages increased for both children and adolescents. Children dropped their fruit intake by more than half a serving and the adolescents dropped by almost a full serving. The number of vegetable servings decreased by half a serving for children and nearly a full serving for adolescents as the consumption of sugars and sweets increased. Among the adolescents, as sweetened grain and presweetened cereal consumption increased, the number of servings of vegetables per day dropped by one-half or more. None of the groups met the recommended three servings per day of dairy. The number of dairy servings decreased by a full serving or more as intakes of sugar-sweetened beverages increased in both age groups. High consumers of sugar-sweetened beverages had the lowest number of dairy servings; approximately one and one-half servings per day. Alternatively, nonconsumers of sugar-sweetened beverages and high consumers of sweetened dairy and presweetened cereals had among the highest number of dairy servings per day.

Discussion

This study determined that intakes of sweetened foods and beverages had both positive and negative impacts on U.S. children and adolescents' intake of key nutrients and food groups. Calcium, folate, and

iron were examined, as U.S. children are known to have a shortfall of these micronutrients [19]. Consumption of excess calories from added sugars and fats, especially saturated fats, as well as the underconsumption of fiber, may have a negative impact on health [18]. Despite a decrease in the percent of calories from saturated fat in the American diet since the 1980s [20], over 88% of children ages 6–18 exceed saturated fat recommendations [21]. Research has also shown that only 39% of children aged 2–17 years are meeting fiber guidelines established by the Dietary Guidelines for Americans [22]. In addition, children aged 2–18 years are not meeting the USDA Food Guide Pyramid suggested recommendations for fruit, vegetables, and dairy foods [22].

In this study, the consumption of sweetened dairy products increased the number of dairy servings and intakes of calcium, as well as the likelihood of children meeting the AI for calcium. Although calcium intakes increased as sweetened dairy products intakes increased for both children and adolescents, calcium intakes remained below the AI at all levels of consumption. Low calcium intakes for children and adolescents are disconcerting, as calcium is essential for growth. In addition to the positive impact of higher calcium intakes on bone health [23], research suggests that increased intakes of calcium and dairy products are associated with lowered body fat [24].

This study determined that the consumption of presweetened cereals, like sweetened dairy products, was positively associated with increased intakes of calcium. Because milk intake is a marker for calcium intake [25], the association between presweetened cereals and calcium intakes likely indicates that most

children and adolescents consumed milk along with the presweetened cereal. In addition, as consumption of presweetened cereals increased, intakes of folate and iron increased. Although all groups of children and adolescents met the DRI for iron, children and adolescents consuming presweetened cereals had a significant increase in iron as consumption levels increased. The increased intakes in folate and iron are most likely a result of the fortification of presweetened cereals with these nutrients. Similarly, past research has shown that children consuming ready-to-eat (RTE) cereals (presweetened or non-sweetened) at least three times per week had higher micronutrient levels and lower intakes of fat and cholesterol than nonconsumers of RTE cereals [26].

Conversely, this study demonstrated that, in general, intakes of sugar-sweetened beverages, sugars and sweets, and sweetened grains had a negative association on intakes of calcium, folate, and iron, and that sugar-sweetened beverages were negatively associated with servings of fruits and dairy products. In general, as children and adolescents increased the consumption of sugar-sweetened beverages, sugar and sweets, and sweetened grains, the likelihood of meeting the AI for calcium decreased. Of particular interest, only children who were nonconsumers of sugar-sweetened beverages had a mean intake of calcium that met the AI. As the consumption of sugar-sweetened beverages, sugar and sweets, and sweetened grains increased, typically, intakes of folate and iron decreased. Furthermore, increased intakes of sugar-sweetened beverages and sweetened grains were associated with higher saturated fat intakes. These associations may be attributed to many children eating more meals and snacks at restaurants and fast food establishments where they consume less fruits and dairy products in comparison with home [20]. The positive association between sugar-sweetened beverages and saturated fat intakes are likely related to the intake of foods high in saturated fat that may typically be eaten when drinking a soft drink. On the contrary, this study demonstrated a negative association between sweetened dairy products and saturated fat intakes. This may be a result of the consumption of more non- or low-fat sweetened dairy foods and beverages, such as flavored milks and yogurt. Another encouraging aspect of consuming sweetened dairy products is that flavored milk has been found to displace soft drinks and fruit drinks in children and adolescents' diets [27]. Thus, the consumption of sweetened dairy products appears to enhance calcium intakes while

displacing nutrient-poor beverages like soft drinks and fruit drinks.

Given that soft drink consumption has increased significantly in both children [5] and adolescents [6], and that regular soft drinks are the major source of added sugars in children's diets [2], the negative impact of sugar-sweetened beverages on the intakes of key nutrients and food groups of children is of concern. Moreover, the increased consumption of sugar-sweetened beverages has been linked with the onset of obesity in children [13], and specifically, the increased consumption of nondiet soft drinks has been positively associated with increased energy intakes [8].

Soft drinks are widely accessible to U.S. school-aged children. Many school districts have exclusive pouring rights contracts with soft drinks manufacturers that promote the sale of soft drinks in schools [28]. Over 50% of the vending machines in high schools are located in cafeterias, of which 81% contain carbonated beverages, 88% juice drinks, and 35% sport drinks, as compared with only 6% of the vending machines containing milk [29].

In summary, increased intakes of sweetened dairy products and presweetened cereals appear to have a positive impact on the intake of critical shortfall nutrients and dairy servings per day among U.S. children and adolescents. Conversely, intakes of sugar-sweetened beverages, sugars and sweets, and sweetened grains in general, negatively impacted the intake of these nutrients, as well as of the fruit, vegetable, and dairy food groups. The findings from this study were encouraging, as U.S. children and adolescents are known to often have a shortfall of calcium, folate, and iron, as well as inadequate intakes of fruits, vegetables, and dairy products [19]. Children and adolescents can enhance their diet quality by consuming sweetened milks and dairy products as well as presweetened cereals in moderation, as an alternative to energy-dense, nutrient-poor foods and beverages such as sugar-sweetened beverages, sugars and sweets, and sweetened grains.

Limitations

Underreporting of dietary intakes is a serious and pervasive problem in dietary survey research [30]. Although studies have not identified foods typically underreported by children and adolescents, adults often underreport their intake of sweetened foods and beverages [31,32]. Considering that energy-dense, nutrient-poor foods and beverages are frequently underreported in adults, intake levels of

sweetened foods and beverages in this study may be underestimated. Thus, the associations demonstrated in this research may be even stronger if the intakes of these foods and beverages were accurately reported.

Conclusion

On average, consumption of sweetened dairy foods and beverages and presweetened cereals had a positive impact on the diet quality of U.S. children and adolescents, whereas sugar-sweetened beverages, sugars and sweets, and sweetened grains had a negative impact on their diet quality.

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