

# Food sources of added sweeteners in the diets of Americans

JOANNE F. GUTHRIE, PhD, MPH, RD; JOAN F. MORTON, MS

## ABSTRACT

**Objective** To identify food sources of added sweeteners in the US diet.

**Design** A descriptive study using data from the US Department of Agriculture (USDA) 1994-1996 Continuing Survey of Food Intakes by Individuals. Each subject provided one 24-hour dietary recall. Intake of added sweeteners was calculated using the USDA Food Guide Pyramid servings database.

**Subjects/setting** A national sample of noninstitutionalized persons aged 2 years and older (N=15,010).

**Statistical analyses** Mean intakes of added sweeteners from all food sources and from specific food categories; percentage contribution of added sweeteners to total energy intake; and percentage contribution of each food category to total intake of added sweeteners. All analyses were conducted for the total sample and for 12 age-gender groups.

**Results** During 1994 to 1996, Americans aged 2 years and older consumed the equivalent of 82 g carbohydrate per day from added sweeteners, which accounted for 16% of total energy intake. In absolute terms, adolescent males consumed the most; as a percentage of energy, male and female adolescents had the highest intakes (averaging 20% of total energy from added sweeteners). The largest source of added sweeteners was regular soft drinks, which accounted for one third of intake. Other sources were table sugars, syrups, and sweets; sweetened grains; regular fruitades/drinks; and milk products.

**Applications/conclusions** Intakes of added sweeteners exceed levels compatible with meeting current dietary recommendations. Knowing food sources of added sweeteners for the overall population and for specific age-gender groups can help dietitians provide appropriate nutrition education. *J Am Diet Assoc.* 2000;100:43-48,51.

The Dietary Guidelines for Americans provide authoritative advice on what Americans should eat to be healthy and form the basis of federal nutrition policy (1,2). The Dietary Guidelines advise Americans to moderate intake of sugars, a recommendation that has been offered, with only slight changes in wording, since the first publication of the guidelines in 1980 (3). One rationale is the role sugars play in promoting dental caries. A second is the low nutrient density of many sugary foods, which, for most people, makes high consumption of sugary foods incompatible with eating a nutritious diet at an energy level that maintains a healthful weight.

The US Dietary Guidelines do not quantify recommended intake of sugars. However, the US Department of Agriculture (USDA) Food Guide, popularly known as the Food Guide Pyramid (4) offers food-based advice for a diet based on the principles of the US Dietary Guidelines that is, a varied, nutritionally adequate diet that is moderate in total fat, saturated fat, cholesterol, sugars, and sodium (5,6). To achieve variety and nutritional adequacy, servings from 5 major food groups are recommended: bread, cereal, rice, grains; vegetables; fruit; milk, milk products; and meat, poultry, fish, dried beans, eggs, nuts, seeds. Minimum energy levels for sample diets are calculated using foods from each food group in their lowest fat-containing form and without added sweeteners.<sup>1</sup> For example, a serving of skim milk is used to develop minimum energy estimates for servings from the milk/milk products group.

For the sake of moderation, fat and sweeteners added to the diet should not exceed the difference between this minimum energy level and a person's energy needs. Recommended fat and saturated fat intakes are further limited by the recommendation that total fat not exceed 30% of energy, with saturated

*J. F. Guthrie is a consumer science specialist with the Center for Food Safety and Applied Nutrition, US Food and Drug Administration, Washington, DC. J. F. Morton is a program analyst with the Veterans Health Administration, Department of Veterans Affairs, Washington, DC; at the time of this study, she was a social scientist with the Center for Nutrition Policy and Promotion, US Department of Agriculture.*

*Address correspondence to: Joanne F. Guthrie, PhD, MPH, RD, FDA/CFSAN/OSAS/Market Studies, 200 C St, SW HFS-727, Washington, DC 20204.*

<sup>1</sup>The Food Guide Pyramid uses the term "sugars" to refer to sweeteners. See the Methods section for further explanation.

**Table 1**

Mean intake of total added sweeteners as gram-equivalents and as a percentage of total energy by age-gender group

Age-gender group	Sample size <sup>a</sup>	Mean intake of total added sweeteners	
		Gram-equivalents <sup>b</sup>	% of total energy
2-5 y old children	2,177	60.9	15.9
6-11 y old children	1,492	90.7	18.6
12-17 y old females	582	97.7	20.1
12-17 y old males	595	141.8	20.4
18-34 y old females	1,293	81.9	17.9
18-34 y old males	1,337	115.0	16.8
35-54 y old females	1,755	63.9	14.9
35-54 y old males	1,859	92.1	14.4
55-64 y old females	799	51.2	12.8
55-64 y old males	806	70.2	12.7
65+ y old females	1,119	44.9	12.4
65+ y old males	1,196	57.5	11.6
Total population, 2 y and older	15,010	82.2	15.8

<sup>a</sup>Unweighted sample size, that is, sample count before survey weights are applied.

<sup>b</sup>Gram-equivalent is defined as an amount of added sweeteners comparable in carbohydrate content to 1 g sucrose.

fat less than 10% of energy; sweeteners are limited only by energy needs. Sample dietary patterns recommend limiting total added sweeteners, on a carbohydrate-content basis,<sup>2</sup> to no more than 6 tsp/day at 1,600 kcal, 12 tsp/day at 2,200 kcal, and 18 tsp/day at 2,800 kcal (6). Assuming 1 tsp table sugar is equivalent to 4 g, each yielding 4 kcal/g, these amounts range from 6% to 10% of energy. Added sweeteners may be incorporated into foods in the 5 major food groups in processing or preparation, or may be obtained from consumption of foods in the tip of the Food Guide Pyramid.

The US Food and Drug Administration Sugars Task Force used data from the USDA 1977-1978 Nationwide Food Consumption Survey (NFCS) and its own database on sugar content of foods to conduct a comprehensive study of the total and added sugars intakes of Americans (7). The task force estimated that, on average, Americans consumed 21% of energy from naturally occurring and added sugars. Added sugars accounted for about 56% of total sugars intake and 11% of energy intake (7). Sugars were defined as the sum of all forms of monosaccharides and disaccharides, and added sugars represented the amount of monosaccharides and disaccharides from sweeteners added during food processing or home preparation (7). Using these data, Lewis et al (8) found that people consuming higher levels of added sugars as a percentage of energy had lower intakes of 11 vitamins and minerals. Intakes of calcium, a nutrient currently viewed as a particular health concern (9), were especially low.

<sup>2</sup>Some sweeteners, such as corn or table syrups, honey, and molasses, are liquids and contain a large amount of water. To express as sweeteners on an equal basis, they are measured on a carbohydrate-content basis.

More recently, USDA has developed and published a Food Guide Pyramid servings database that reports the added "sugars" (ie, sweeteners) content of foods, as defined by the USDA Food Guide (6,10). Applying this database to consumption data from its 1994-1996 Continuing Survey of Food Intakes by Individuals (CSFII), the USDA Food Surveys Research Group estimated average intake of added "sugars" at approximately 16% of energy (11). This is much higher than the estimate of Glinsmann et al (7), and there are several reasons for the higher estimate. First, as mentioned previously, estimates of added sugars intakes in the study of Glinsmann et al (7) represent the amount of monosaccharides and disaccharides from sweeteners. The estimates from the 1994-1996 CSFII, on the other hand, represent the amount of total carbohydrate from sweeteners (ie, dry weight of sweeteners), which includes trisaccharides and higher saccharides. Many corn-derived sweeteners contain large amounts of these saccharides; for example, only 33% or less of the carbohydrates in some commonly used corn syrups are monosaccharides and disaccharides; the remaining 67% or more are trisaccharides and higher saccharides (7). Corn-derived sweeteners make up a large proportion of the sweeteners in the US food supply (12), so this distinction is important. Second, estimates from the 1994-1996 CSFII excluded children younger than the age of 2 years, whereas estimates from the 1977-1978 NFCS included all ages. Third, the 1994-1996 CSFII differed considerably in dietary interviewing methodology from previous USDA surveys (10). Therefore, the difference in the estimates developed by Glinsmann et al (7) and the later survey cannot be used to draw conclusions about trends in intake of added sugars/sweeteners. Nevertheless, it is clear that added sugars/sweeteners play a substantial role in the US diet, and information about their food sources would be useful to nutrition educators.

Previous research suggests that nutrition education is more effective when dietary behaviors are defined specifically (13). Identifying foods that contribute most notably to intake of added sweeteners helps dietitians and other health professionals prioritize areas for dietary improvement and tailor education and counseling to food intake patterns. This study identifies important food sources of added sweeteners in the US diet for the general population and for specified age-gender groups.

## METHODS

### Sample

Data were obtained from the 1994-1996 CSFII in which a complex sampling design was used to obtain a nationally representative sample of persons living in households in the United States (10). Up to 2 nonconsecutive 24-hour recalls of dietary intake were obtained from participants. Day 1 response rate, that is, provision of at least the first day's dietary recall, was 80% (10). To maximize sample size, we used only the first day of dietary data. US Dietary Guidelines recommendations apply only to those aged 2 years and older; therefore, younger children were excluded. Children who were breast-feeding were also excluded. The resulting sample consisted of 15,010 people.

USDA-provided survey weights for the 1994-1996 CSFII adjust for variable selection probabilities, differential non-response, and sampling considerations. These weights were used in all analyses to provide results more generalizable to the US population.

**Table 2**

Mean intake of added sweeteners by food category for all people aged 2 years and older and percentage contribution to total intake of added sweeteners

Food category and examples of foods containing added sweeteners	Mean Intake (gram-equivalents) <sup>a</sup>	% of total intake
<b>Grains</b>		
Breakfast cereals (presweetened cereals)	3.6	4.4
Sweetened grains (cookies, cakes)	10.6	12.9
Other grains (cinnamon toast; honey-nut waffle)	4.8	5.8
<b>Fruit/fruit juices (fruit cocktail in heavy syrup; sweetened grape juice)</b>	1.1	1.3
<b>Vegetables (candied sweet potatoes, glazed carrots)</b>	1.1	1.3
<b>Milk/milk products (chocolate milk, ice cream, sweetened yogurt)</b>	7.1	8.6
<b>Meat, poultry, fish, dried beans, eggs, nuts (spareribs with barbeque sauce, baked beans with sweet sauce)</b>	1.7	2.1
<b>Fats/oils (honey butter, honey-mustard salad dressing)</b>	0.7	0.9
<b>Sugars, sweets, sweetened beverages</b>		
Sugars/sweets (table sugar, honey, syrups, candies, jams, jellies, gelatin desserts)	13.2	16.1
Soft drinks, regular (colas, ginger ale, root beer)	27.1	33.0
Soft drinks, low calorie (diet colas, diet ginger ale, diet root beer)	0.1	0.1
Fruitades/drinks, regular (fruit punch, fruit juice drink, lemonade)	8.0	9.7
Fruitades/drinks, low calorie (low-calorie fruit drink, low-calorie lemonade)	<0.1	<0.1
<b>Other beverages (sweetened tea and coffee, wine cooler, frozen daiquiri)</b>	3.0	3.6

<sup>a</sup>Gram-equivalent is defined as an amount of added sweeteners comparable in carbohydrate content to 1 g sucrose.

**Table 3**

Mean intake of added sweeteners by food category of children and adolescents and percentage contribution to total intake of added sweeteners

Food category	Children aged 2-5 y		Children aged 6-11 y		Females aged 12-17 y		Males aged 12-17 y	
	Mean (g-eq) <sup>a</sup>	%	Mean (g-eq)	%	Mean (g-eq)	%	Mean (g-eq)	%
<b>Grains</b>								
Breakfast cereals	5.4	8.9	7.2	7.9	4.7	4.8	8.5	6.0
Sweetened grains	7.7	12.6	12.5	13.8	10.7	11.0	13.9	9.8
Other grains	4.1	6.7	4.9	5.4	4.3	4.4	6.5	4.6
<b>Fruit/fruit juices</b>	1.4	2.3	1.5	1.7	1.2	1.2	0.8	0.6
<b>Vegetables</b>	0.7	1.1	1.0	1.1	0.9	0.9	1.6	1.1
<b>Milk/milk products</b>	6.3	10.3	9.6	10.6	7.1	7.2	8.8	6.2
<b>Meat, poultry, fish, dried beans, eggs, nuts</b>	0.9	1.5	1.4	1.5	1.1	1.1	1.8	1.3
<b>Fats/oils</b>	0.2	0.3	0.3	0.3	0.5	0.5	0.7	0.5
<b>Sugars, sweets, sweetened beverages</b>								
Sugars/sweets	12.7	20.9	18.9	20.8	16.5	16.8	21.3	15.0
Soft drinks, regular	8.9	14.6	19.9	21.9	36.2	37.1	57.7	40.7
Soft drinks, low calorie	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1
Fruitades/drinks, regular	11.8	19.4	12.2	13.4	10.9	11.2	16.7	11.8
Fruitades/drinks, low calorie	<0.1	<0.1	<0.1	<0.1	0.1	0.1	0.1	0.1
<b>Other beverages</b>	0.8	1.3	1.4	1.5	3.5	3.6	3.2	2.3

<sup>a</sup>Mean (g-eq)=mean intake in gram-equivalents. Gram-equivalent is defined as an amount of added sweeteners comparable in carbohydrate content to 1 g sucrose. Means for each food category may not sum perfectly to mean total intakes of added sweeteners shown in Table 1 because of rounding.

### USDA Food Guide Pyramid Servings Database

The USDA Food Guide Pyramid servings database defines added “sugars” as “all sugars used as ingredients in processed and prepared foods” as well as “sugars eaten separately or added to foods at the table” (10). Included as added “sugars” in the database are white and brown sugar, corn syrup, corn syrup solids, high fructose corn syrup, malt syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey, molasses, anhydrous dextrose, crystal dextrose, saccharin, and aspartame.<sup>3</sup> Sugars naturally present in foods, such as fructose in fruit or lactose in milk, are not included. Quantities are expressed in terms of teaspoons of sugar; 1 tsp added sugar is defined as the quantity of a sweetener containing the same amount of carbohydrate as a teaspoon (4 g) of table sugar. Thus, the Food Guide Pyramid servings database for added “sugars” includes all added sweeteners, some of which (eg, corn-derived sweeteners) may include trisaccharide and higher saccharides, on a carbohydrate-equivalent basis. In contrast, US Food and Drug Administration regulations, which guide nutrition labeling, define sugars as the sum of all monosaccharides and disaccharides in a food (14). To prevent confusion or misinterpretation, we use the term *sweeteners* in this article to refer to Food Guide Pyramid servings and estimates derived from them and the term *sugars* to refer to monosaccharides and disaccharides.

Identifying foods that contribute most notably to intake of added sweeteners helps dietitians and other health professionals prioritize areas for dietary improvement and tailor education and counseling to food intake patterns

### Use of Gram-Equivalents to Express Intake of Added Sweeteners

In this article the teaspoon values in the database were multiplied by 4 to give values for added sweeteners that were comparable, or gram-equivalent, to 4 g table sugar on a carbohydrate-content basis. This was done because dietitians and other nutrition scientists work with gram quantities of nutrients and food components, and we believed expressing values for added sweeteners in gram-equivalent quantities would be

<sup>3</sup>Saccharin and aspartame are noncarbohydrate-intense sweeteners; however, they often contain small amounts of dextrose or other carbohydrates for functional purposes. These carbohydrates are included in the database as added sugars.

more readily understandable and more comparable to other published dietary intake research.

### Food Categories

Food categories basically correspond to the USDA Food Guide. Some categories hypothesized to be particularly important sources of added sweeteners were differentiated further. Grains were subdivided to examine 2 subcategories of particular interest—breakfast cereals and sweetened grains—as well as other grains. Foods in the tip of the Food Guide Pyramid were also subdivided for closer examination.

### Statistical Analysis

Mean intakes of total added sweeteners were estimated for all people aged 2 years and older and for 12 age-gender groups (groupings are shown in Table 1). Mean intakes of added sweeteners obtained from each food category were also obtained. The percentage of energy obtained from added sweeteners was assessed using an estimate of 4 kcal per gram-equivalent of added sweeteners.

## RESULTS

### Consumption of Added Sweeteners

Consumption of added sweeteners from all food sources is shown in Table 1. The total population aged 2 years and older averaged an intake of 82.2 gram-equivalents of added sweeteners. For both males and females, intake was highest in adolescence. Females aged 12 to 17 years consumed 97.7 gram-equivalents of added sweeteners and males of that age consumed 141.8 gram-equivalents, the largest amount of any age-gender group. Intake declined in adulthood, reaching a low of 44.9 gram-equivalents for women aged 65 years and older and 57.5 gram-equivalents for men aged 65 years and older.

Overall intake of added sweeteners averaged 15.8% of energy (Table 1). The proportion of energy obtained from added sweeteners peaked in adolescence at approximately 20% of energy for both males and females and declined with age to a low of 12.4% of energy for women and 11.6% of energy for men in the oldest age group.

### Food Sources of Added Sweeteners

Mean intakes of added sweeteners by food category for all people aged 2 years and older are shown in Table 2. The most important source of added sweeteners was regular soft drinks, which contributed one third of intake of added sweeteners. Sugars/sweets were second in importance, contributing 16.1% of added sweeteners; sweetened grains ranked third, contributing 12.9% of added sweeteners. Regular fruitades/drinks were also important sources of added sweeteners; they contributed almost 10% of total intake. Together, these 4 food categories provided almost three quarters (72%) of the intake of added sweeteners.

Food sources of added sweeteners by age-gender group are shown in Tables 3 through 5. Despite differences across groups, findings generally emphasize the importance of regular soft drinks as sources of added sweeteners. Regular soft drinks were the major contributor of added sweeteners to the diets of all age-gender groups except the youngest children (2 to 5 years) and the older adults (men aged 65 years and older; women aged 55 years and older). The percent contribution to added sweetener intake from soft drinks climbed throughout childhood and adolescence and peaked at age 18 to 34 years for

**Table 4**  
Mean intake of added sweeteners by food category of adult females and percentage contribution to total intake of added sweeteners

Food category	Females aged 18-34 y		Females aged 35-54 y		Females aged 55-64 y		Females aged 65 y +	
	Mean (g-eq) <sup>a</sup>	%	Mean (g-eq)	%	Mean (g-eq)	%	Mean (g-eq)	%
<b>Grains</b>								
Breakfast cereals	3.3	4.0	2.2	3.4	1.6	3.1	2.1	4.7
Sweetened grains	8.8	10.7	9.0	14.1	11.0	21.5	8.8	19.6
Other grains	3.9	4.8	4.3	6.7	3.5	6.8	4.3	9.6
<b>Fruit/fruit juices</b>	0.8	1.0	0.8	1.3	1.3	2.5	2.1	4.7
<b>Vegetables</b>	0.9	1.1	0.9	1.4	0.9	1.8	0.9	2.0
<b>Milk/milk products</b>	6.0	7.3	6.3	9.9	6.0	11.7	5.9	13.2
<b>Meat, poultry, fish, dried beans, eggs, nuts</b>	1.5	1.8	1.5	2.3	1.2	2.3	1.3	2.9
<b>Fats/oils</b>	0.8	1.0	0.8	1.3	0.8	1.6	0.6	1.3
<b>Sugars, sweets, sweetened beverages</b>								
Sugars, sweets	10.7	13.1	11.8	18.5	9.2	18.0	7.9	17.6
Soft drinks, regular	33.2	40.5	18.1	28.3	10.1	19.7	6.1	13.6
Soft drinks, low calorie	0.2	0.2	0.2	0.3	0.2	0.4	0.1	0.2
Fruitades/drinks, regular	8.2	10.0	5.2	8.1	2.9	5.7	3.1	6.9
Fruitades/drinks, low calorie	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
<b>Other beverages</b>	3.6	4.4	2.8	4.4	2.4	4.7	1.6	3.6

<sup>a</sup>Mean (g-eq)=mean intake in gram-equivalents. Gram-equivalent is defined as an amount of added sweeteners comparable in carbohydrate content to 1 g sucrose. Means for each food category may not sum perfectly to mean total intakes of added sweeteners shown in Table 1 because of rounding.

**Table 5**  
Mean intake of added sweeteners by food category of adult males and percentage contribution to total intake of added sweeteners

Food category	Males aged 18-34 y		Males aged 35-54 y		Males aged 55-64 y		Males aged 65 y +	
	Mean (g-eq) <sup>a</sup>	%	Mean (g-eq)	%	Mean (g-eq)	%	Mean (g-eq)	%
<b>Grains</b>								
Breakfast cereals	3.6	3.1	2.6	2.8	2.4	3.4	2.7	4.7
Sweetened grains	11.0	9.6	12.4	13.5	10.8	15.4	11.9	20.7
Other grains	5.6	4.9	5.6	6.1	5.6	8.0	5.0	8.7
<b>Fruit/fruit juices</b>	0.8	0.7	0.8	0.9	1.2	1.7	1.8	3.1
<b>Vegetables</b>	1.4	1.2	1.4	1.5	1.1	1.6	1.1	1.9
<b>Milk/milk products</b>	6.2	5.4	8.7	9.4	7.1	10.1	7.8	13.4
<b>Meat, poultry, fish, dried beans, eggs, nuts</b>	2.7	2.3	2.0	2.2	2.4	3.4	2.5	4.3
<b>Fats/oils</b>	0.8	0.7	0.9	1.0	0.9	1.3	0.7	1.2
<b>Sugars, sweets, sweetened beverages</b>								
Sugars/sweets	12.8	11.1	14.8	16.1	13.2	18.8	11.7	20.3
Soft drinks, regular	54.9	47.7	31.9	34.7	17.4	24.8	7.3	12.7
Soft drinks, low calorie	0.1	0.1	0.2	0.2	0.2	0.3	0.1	0.2
Fruitades/drinks, regular	10.4	9.0	6.4	6.9	5.5	7.7	3.4	5.9
Fruitades/drinks, low calorie	<0.1	<0.1	<0.1	<0.1	0.1	0.1	<0.1	<0.1
<b>Other beverages</b>	4.7	4.1	4.3	4.7	2.4	3.4	1.6	2.8

<sup>a</sup>Mean (g-eq)=mean intake in gram-equivalents. Gram-equivalent is defined as an amount of added sweeteners comparable in carbohydrate content to 1 g sucrose. Means for each food category may not sum perfectly to mean total intakes of added sweeteners shown in Table 1 because of rounding.

both men and women. Subsequently, intake steadily declined and reached its lowest level among the oldest adults. Men aged 65 years and older were the only age-gender group for which regular soft drinks were not among the top 3 food sources of added sweeteners.

Regular soft drinks were the major contributor of added sweeteners to the diets of all age-gender groups except the youngest children and the older adults

Other important sources of added sweeteners included sugars/sweets, regular fruitades/drinks, grains (especially sweetened grains), and for some age-gender groups, milk/milk products. Sugars/sweets were the top contributor for children 2 to 5 years old and were among the top 3 contributors of added sweeteners for all age-gender groups. Fruitades/drinks were especially popular among children 2 to 5 years old; they contributed 19.4% of intake of added sweeteners. This was the only age group for which these beverages contributed more added sweeteners than did regular soft drinks. However, fruitades/drinks continued to be important in the diets of older children and adolescents; they contributed more than 10% of the intakes of added sweeteners in these age groups. Fruitades/drinks also made notable contributions to the intakes of added sweeteners of young adult women and men (18 to 34 years old) by contributing 10% and 9% of intakes, respectively.

The grains group was an important contributor to the intake of added sweeteners of most age-gender groups. Most of this contribution came from sweetened grains, which were among the top 3 contributors of added sweeteners for all age-gender groups except children 2 to 5 years old and male and female adolescents. Sweetened grains were especially important sources of added sweeteners in the diets of 55- to 64-year-old women and people aged 65 years and older of both genders. For these age-gender groups, sweetened grains contributed approximately one fifth of the intake of added sweeteners. Breakfast cereals were less important as a source of added sweeteners, although they did contribute 8.9% of added sweeteners in the diets of 2- to 5-year-old children and 7.9% in the diets of 6- to 11-year-old children.

Milk products were somewhat important as sources of added sweeteners for several age-gender groups. Among children younger than 12 years they contributed approximately 10% of total added sweeteners, but their importance declined in adolescence and young adulthood. Among adults 35 years and older milk products regained importance and contributed 9%

or more to total intake of added sweeteners for these age groups. Among men aged 65 years of age and older, milk products were the third-largest source of added sweeteners.

## DISCUSSION

Sample dietary patterns based on the Food Guide Pyramid suggest intakes of added sweeteners ranging from 6% to 10% of energy, a range exceeded, on the average, by the general US population and by all age-gender groups we studied. Intakes as a percentage of energy were highest among male and female adolescents; they were also high among children 6 to 11 years old and young adults 18 to 34 years old. High intakes of added sweeteners may make it difficult for all but the most active people to consume recommended amounts of servings from the 5 major food groups without consuming excess energy.

Foods found in the tip of the Food Guide Pyramid—sugars, sweets, and beverages—account for 62.5% of total added sweeteners. This finding supports the concern that highly sweetened foods are often low in nutrient density. More specifically, results indicate that intake of regular soft drinks is the major factor in consumption of added sweeteners of most Americans; it accounts for one third of intake of added sweeteners.

Evidence is accumulating that consumption of regular soft drinks has increased in recent years. Based on USDA food consumption survey data, Morton and Guthrie (15) found increased intake of regular soft drinks to be one of the major changes in children's diets between 1989-1991 and 1994-1995. Using the same data set, Chanmugam et al (16) found that consumption of soft drinks by adults also increased during the same time period. These data are corroborated by USDA reports that availability of regular soft drinks rose from 34.7 gallons per capita in 1987-1991 to 41.4 gallons per capita in 1997 (17). In the private sector, the NPD Group, a market research firm, reported that consumption of soft drinks increased more rapidly than consumption of any other food group during the 1990s (18).

Foods from the grain group of the Food Guide Pyramid were also important contributors to intake of added sweeteners. Concern has been expressed about intake of presweetened breakfast cereals, especially by children. However, sweetened grains were actually larger contributors of added sweeteners, and many are high in fat. Grain intake has been increasing in recent years; unfortunately, little of this intake is whole grains, as recommended by the US Dietary Guidelines and the Healthy People 2000 nutrition objectives (19). Nutrition education to indicate recommended types of grains and encourage their consumption is needed.

Milk products were notable sources of added sweeteners for some age-gender groups. Some sweetened foods in this group are calcium-rich (eg, chocolate milk); others are lower in calcium and higher in fat (eg, sweetened whipped cream). Because milk products are major sources of calcium in US diets and milk consumption has been declining (20), it is important to ensure that nutrition education messages discouraging consumption of added sweeteners do not inadvertently discourage consumption of the more calcium-rich foods within this category.

One reason for moderating intake of added sweeteners is that they may displace more nutrient-dense foods. Morton and Guthrie (15) found that diets of children in 1994-1995 were higher in reported energy intake than diets in 1989-1991, but nutrient intakes were generally similar. An exception was calcium intake, which declined slightly. This decline is not

surprising, as consumption of milk decreased during this time period whereas consumption of soft drinks increased. Previous researchers have found that soft drinks tend to displace milk in the diets of teenagers, which has negative implications for diet quality (21,22). This displacement may also be a problem for adults. Guthrie (23) found that adult women whose diets failed to meet the 1989 Recommended Dietary Allowance (24) for calcium drank significantly more regular soft drinks than did those whose diets met the Recommended Dietary Allowance. Low calcium intakes are a public health concern, so this displacement effect is particularly troubling.

If, on the other hand, added sweeteners are consumed in addition to more nutritious foods, the diet may be excessive in energy, thereby promoting obesity. Previous research indicates that increased consumption of soft drinks may be a major factor in a measured increase in energy intakes of children and adults between 1989-1991 and 1994-1995 (15,16). Some of the difference in measured energy intake between the 2 periods may be an artifact of changes in survey methodology (10). In addition, the association between high intake of sugar and obesity has been questioned by many researchers (25,26). However, meta-analysis of studies of energy compensation in response to energy manipulations using liquid and solid foods indicates that compensation for increases in energy from carbohydrates ingested in fluids is significantly less precise than for solids, which results in the potential for increased total energy intake (27). Given the increase in consumption of soft drinks and the overall high intakes of added sweeteners by Americans, ongoing monitoring of the impact of intake of added sweeteners on nutrient intake, energy intake, and body weight is important. Previously, the lack of a public access database on the added sweeteners content of foods limited opportunities for this type of research. The USDA Food Guide Pyramid servings database should remedy this problem and encourage more research.



## APPLICATIONS/CONCLUSIONS

Americans' intakes of added sweeteners exceed levels typically recommended for a diet that meets current recommendations. Intakes of adolescents are particularly high. The largest source of added sweeteners in American diets is regular soft drinks, and their consumption appears to be increasing. Other important sources are sugars/sweets; fruitades/drinks; grains, especially sweetened grains; and milk products.

Knowing major food sources of added sweeteners for the general population and for specific age-gender groups, dietetic professionals can:

- emphasize the most important food sources of added sweeteners in the US diet when developing educational materials for the general population on how to follow the US Dietary Guideline recommendation to choose a diet moderate in sugars; and
- when working with a specific age-gender group, tailor educational and counseling messages concerning added sweetener intakes to the most important food sources for that group.

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