Current Research

Drinking Flavored or Plain Milk Is Positively Associated with Nutrient Intake and Is Not Associated with Adverse Effects on Weight Status in US Children and Adolescents

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ABSTRACT

Objective Little research has been conducted on health effects associated with consumption of flavored milk. The purposes of this study were to compare nutrient intakes and body measures among children and adolescents drinking flavored milk (with or without plain milk), exclusively plain milk, and no milk.

Design Data used in the study included intakes reported in 24-hour dietary recalls and height and weight measurements collected during a physical examination in the 1999-2002 National Health and Nutrition Examination Surveys. The milk drinking status of each person was identified, and nutrient intakes and body mass index (BMI) measures were determined by milk drinking status.

Subjects The study population included 7,557 children and adolescents aged 2 to 18 years.

Statistical analysis Comparisons among mean milk intakes, energy and nutrient intakes, and BMI measures by milk drinking status were completed using linear regression analysis.

Results Children and adolescents who included flavored milk in their diets reported higher total milk intakes than consumers of exclusively plain milk ($P<0.05$). Intakes of vitamin A, calcium, phosphorus, magnesium, potassium, and saturated fat (adjusted for energy intake and age) were generally comparable among milk drinking groups, whereas intakes by milk nondrinkers were significantly lower ($P<0.05$). Among females aged 12 to 18 years, calcium intakes by flavored and exclusively plain milk drinkers were 992±41.5 and 1,038±22.5 mg/day, respectively, whereas intake by nondrinkers was 576±11.7 mg/day. Intake of added sugars did not differ between flavored milk drinkers and milk nondrinkers. BMI measures of milk drinkers were comparable to or lower than measures of nondrinkers ($P<0.05$).

Conclusions Findings from this study suggest that consumption of either flavored or plain milk is associated with a positive influence on nutrient intakes by children and adolescents and is not associated with adverse effects on BMI measures.

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Milk is a key source of macronutrients, calcium, magnesium, phosphorus, vitamin D, vitamin A, riboflavin, vitamin B-12, zinc, and potassium for US children and teenagers (1-6), and milk drinkers are more likely to meet dietary recommendations for many nutrients (7-9). Other beverages contribute to energy intakes but provide fewer nutrients. Fruit juices are top contributors to intakes of vitamin C and folate (1,6). Sugar-sweetened beverages such as soft drinks and fruit drinks provide significant proportions of daily energy and added sugars intakes, and fruit drinks make small contributions to vitamin C intakes (1,6).

Several of the nutrients provided by milk are important for optimal health and growth (10-13). The Dietary Guidelines for Americans recommend that children aged 2 to 8 years consume 2 c/day fat-free or low-fat milk or equivalent dairy servings, and that all people aged 9 years and older consume three dairy servings per day (14). However, only about one third to one half of American children and adolescent boys consume the recommended number of dairy servings, and fewer than one in five adolescent girls meets the recommendation (15). Approximately 60% to 80% of total dairy servings consumed by children and adolescents are consumed as milk, either as a beverage or as an ingredient in mixtures such as pudding or soup (15).

Flavored milks provide another option for meeting the recommended intakes of dairy products, and research in schools shows that students purchase more milk when milk offerings are enhanced and include flavored milk (16). Servings of plain milk and chocolate milk provide essentially identical amounts of protein, total and satu-

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rated fat, calcium, phosphorus, magnesium, vitamin A, riboflavin, and potassium. Milk is a source of naturally occurring sugars, with each 8 fl oz serving of 1% (low-fat) plain milk providing approximately 13 g lactose per cup (17). A serving of low-fat plain milk provides approximately 100 kcal whereas a serving of low-fat chocolate milk delivers approximately 160 kcal; added sugars account for the difference in energy content (17). The added sugars content of flavored milks does vary, and products prepared with noncaloric sweeteners provide levels of energy and added sugars more similar to levels in plain milk. For example, chocolate milk made from nonfat milk with a combination of nutritive and non-nutritive sweeteners provides 120 kcal per 8 fl oz serving (18).

In most of the research on contributions of beverages to nutrient intakes, plain and flavored milks are typically grouped together in a single milk or dairy category. Little research has been conducted to examine nutrient intakes by consumers of flavored milk. Johnson and colleagues (19) found that consumption of flavored milk was significantly and positively associated with calcium and phosphorus intakes, but found no relationship between flavored milk intake and consumption of added sugars. In another study (20), consumption of sweetened dairy products (a category including flavored milks, flavored yogurts, ice creams, and puddings) was associated with higher intakes of dairy servings and calcium by children and adolescents, and higher intakes of added sugars by children, though sweetened dairy product intake was not associated with added sugars intakes by adolescents.

Some schools limit children's access to flavored milk presumably due to concerns that the beverages provide unhealthful levels of added sugars and fat, therefore potentially contributing to the childhood obesity epidemic (21). Childhood obesity is a significant concern in the United States; data collected between 2003 and 2004 indicate that 17.1% of children and adolescents aged 2 through 19 years were overweight (22).

We are unaware of evidence that consumption of flavored milk is associated with increased risk for obesity. Results from cross-sectional, longitudinal, and intervention studies suggest that increased milk or dairy product consumption, which may include flavored milk, has no effect on body measures in children or adolescents (23-27), or is inversely related to body measures (28-30).

The purpose of this study was to compare nutrient intakes of children and adolescents drinking flavored milk (flavored milk only or both flavored and plain milk), those drinking exclusively plain milk, and those drinking little or no milk. Additionally, body mass index (BMI) and BMI *z* scores were compared by milk drinking status.

METHODS

Sample Population

The study population consisted of children and adolescents included in the 1999-2000 and 2001-2002 National Health and Nutrition Examination Surveys (NHANES) conducted by the National Center for Health Statistics, Division of Health Examination Statistics, in the Centers for Disease Control and Prevention of the US Department of Health and Human Services. The dietary recall component of the survey was jointly developed by the Department of Health and Human Services and the US Department of Agriculture. The populations for these surveys were selected as multistage probability samples of the civilian noninstitutionalized US population, and the results provide nationally representative nutrition and health data and prevalence estimates for nutrition and health status measures (31,32). In these surveys, low-income persons, adolescents, adults ages 60 years and older, African Americans, and Mexican Americans were oversampled to provide more reliable estimates for these subpopulations.

A total of 8,503 children and adolescents aged 2 to 18 years were interviewed in NHANES 1999-2002, and 8,181 completed the examination component in which trained dietary interviewers collected detailed information on all foods and beverages consumed in the previous 24 hours (midnight to midnight). Proxy respondents were permitted for survey participants younger than age 6 years, and assisted interviews were completed with participants aged 6 to 11 years. Recalls were collected using computerized, multiple-pass methods. These methods guide the respondent through the dietary intake period more than once and consequently provide multiple opportunities to identify foods and specific details about the foods consumed during the recall period (33). The dietary recalls from 7,557 nonpregnant, nonlactating, nonfasting, and nonbreastfeeding children and adolescents were determined by the National Center for Health Statistics to be reliable and meet minimum criteria based on completeness of food descriptions provided and identification of amounts eaten (31,32).

To study nutrient intakes of children and adolescents based on milk drinking status, NHANES 1999-2002 respondents were grouped into five subpopulations: children aged 2 to 5 years, boys aged 6 to 11 years, girls aged 6 to 11 years, boys aged 12 to 18 years, and girls aged 12 to 18 years (Table 1).

Categorization of Respondents by Milk Drinking Status

The dietary records of each child and adolescent were reviewed and each participant was categorized as one of three types of cow's milk drinkers: a flavored milk drinker, an exclusively plain milk drinker, or a nondrinker. Flavored milk was defined as either ready-to-drink flavored fluid milk or flavored milk prepared from plain fluid milk and flavored syrups or powder. Plain milk included all fluid, plain milk, excluding evaporated milk and sweetened condensed milk. The plain milk portion of unflavored beverage mixtures or combinations (eg, milk in a latte or milk consumed with coffee or tea) was categorized as plain milk.

Milk-based meal replacements, milkshakes, eggnog, beverages made with milk ingredients, such as Yoo-Hoo (Cadbury Schweppes, Plano, TX), and cocoa beverages made from flavored powders and water were not counted as either flavored or plain milk in this analysis because these beverages contain milk ingredients but are not fluid milk. Reconstituted dry milk was not included as it was seldom consumed.

Based on these definitions of flavored and plain milk, the total amount of both flavored and plain milk consumed by each respondent on the day of recall was calculated by summing the contributions from each qualify-

Table 1. Mean total, flavored, and plain milk intake by milk drinking status of children and adolescents aged 2 to 18 years (N=7,557), based on data from the 1999-2002 National Health and Nutrition Examination Surveys

Population and milk drinking status[b]	n	Mean Milk Intake (fl oz/d)[a]			
		%[c]	Total	Flavored	Plain
			← mean± standard error →		
Children 2 to 5 y					
Flavored milk	305	20.0	19.5±1.11[x]	12.0±0.64	7.5±0.92[y]
Exclusively plain milk	977	65.1	13.8±0.60[y]	0.0±0.00	13.8±0.60[x]
Nondrinker	239	14.9	0.0±0.02	0.0±0.00	0.0±0.02
Boys 6 to 11 y					
Flavored milk	270	21.3	19.8±1.34[x]	12.2±1.25	7.5±0.8[y]
Exclusively plain milk	542	54.7	13.1±0.71[y]	0.0±0.00	13.1±0.71[x]
Nondrinker	249	24.0	0.0±0.01	0.0±0.00	0.0±0.01
Girls 6 to 11 y					
Flavored milk	235	21.7	13.7±0.61[x]	9.1±0.48	4.6±0.56[y]
Exclusively plain milk	533	54.9	11.4±0.50[y]	0.0±0.00	11.4±0.50[x]
Nondrinker	268	23.4	0.0±0.00	0.0±0.00	0.0±0.00
Boys 12 to 18 y					
Flavored milk	259	14.9	21.9±1.62[x]	13.0±1.04	9.0±0.82[y]
Exclusively plain milk	890	46.2	17.1±0.79[y]	0.0±0.00	17.1±0.7[x]
Nondrinker	846	39.0	0.0±0.01	0.0±0.00	0.0±0.01
Girls 12 to 18 y					
Flavored milk	196	9.4	15.8±0.98[x]	10.6±0.85	5.2±0.68[y]
Exclusively plain milk	763	42.1	13.1±0.58[y]	0.0±0.00	13.1±0.58[x]
Nondrinker	985	48.5	0.0±0.00	0.0±0.00	0.0±0.00

[a]Mean values of 0.0 are <0.05 and standard error values of 0.00 are <0.005. Different superscripts (x,y) between milk groups (flavored milk vs exclusively plain milk) within each age–sex group in the total milk or plain milk column indicate a statistically significant difference between groups ($P<0.05$).
[b]Milk drinking status based on consumption of milk as a beverage or in ready-to-eat breakfast cereal; flavored milk drinkers may have consumed plain milk in addition to flavored milk.
[c]Weighted percent of the population.

ing reported intake. Each respondent was then categorized into a milk drinking status category. The group of flavored milk consumers includes all children and adolescents who reported consumption of flavored milk as a beverage or in a cereal; flavored milk drinkers may also have reported intake of plain milk. The exclusively plain milk group includes children and adolescents who reported intake of plain milk only. The category of nondrinkers therefore represents children and adolescents who reported consumption of less than ¼ c milk as a beverage or with ready-to-eat cereal.

The intent of this research was to determine if children and adolescents who include flavored milk in their diets (either exclusively or in combination with plain milk) have different nutrient intakes or BMI measures compared to children and adolescents drinking exclusively plain milk or no milk. Only individuals reporting a total daily intake of at least ¼ c milk were classified as milk drinkers. This volume of milk was used as a minimum criterion in the study as it provides meaningful contributions of many nutrients. For example, ¼ c low-fat chocolate milk provides approximately 72 mg calcium, 106 mg potassium, and 122 IU vitamin A (17). A ¼-c portion of flavored milk may also provide meaningful energy contributions with respect to BMI. One-quarter cup nonfat chocolate milk contains approximately 35 kcal (34), whereas low-fat, reduced-fat or whole chocolate milk provide approximately 40, 48, or 52 kcal per ¼ c, respectively (17). Boys and girls aged 3 to 8 and 9 to 18 years require 20 and 25 kcal per day, respectively, for growth (35). Thus, this amount of flavored milk provides sufficient energy to place a child or adolescent in positive energy balance, which over time could theoretically be positively associated with BMI.

Estimation of Nutrient Intakes

The US Department of Agriculture Multi-Year Food and Nutrient Database for Dietary Studies, 1.0 (36) was used as the primary data source to calculate intakes of energy and most nutrients for each survey respondent. Values for the remaining nutrients or constituents were obtained from complementary databases or imputed (15,37). Results from analysis of intakes of energy, macronutrients, cholesterol, added sugars, calcium, phosphorus, magnesium, potassium, and vitamin A are reported here. Milk is an important source of these vitamins and minerals, and for some or most children or adolescents, dietary intakes are inadequate (38). Vitamin D–fortified milk is also the key source of dietary vitamin D in the United States, and intakes may be suboptimal for some young people (2). This vitamin is not included in the nutrient database for NHANES 1999-2002, thus it was not included in this analysis.

Energy and nutrient intakes on the day of dietary recall were calculated for each respondent by multiplying the food code-specific energy and nutrient concentration

data by the corresponding weight (in grams) of each reported food and summing contributions from all foods.

BMI and BMI *z* Score Data

People participating in NHANES 1999-2002 were asked to undergo an extensive physical examination during which height and body weight were measured and recorded. BMI values were calculated as kg/m^2. Age- and sex-specific BMI *z* scores were calculated using data files available from the Centers for Disease Control and Prevention (39).

Statistical Analysis

Mean intakes of flavored milk, plain milk, total milk, energy, and nutrients were estimated for each milk-drinking status group. Milk volumes were calculated assuming 244 g and 250 g per 8 fl oz plain and flavored milk, respectively. Mean BMI and BMI *z* scores were estimated for each age, sex, and milk-drinking status group.

Nutrient intakes were adjusted for total energy intake and age using linear regression to control for independent associations between these variables and nutrient intakes; analyses for the group of boys and girls aged 2 to 5 years also were adjusted for sex. Adjustment for energy intake allows examination of differences between nutrient intakes based on group differences in the types of foods consumed, rather than on differences in the energy value of foods and beverages consumed. An adjustment for age was included to account for differences in consumption patterns that may be related to the range of ages within each group. The adjusted mean nutrient intakes for each milk-drinking status group therefore represent nutrient intakes predicted based on equal energy intakes and age distributions (and sex distribution in the case of the 2- to 5-year-olds) among all milk-drinking groups within an age–sex category.

All analyses were completed with NHANES sampling weights to adjust for differences in subpopulation representation; results therefore can be considered representative of the US population aged 2 to 18 years. Error terms and statistical comparisons were generated using STATA (version 9.2, 2007, StataCorp LP, College Station, TX) commands appropriate for the complex sample design of NHANES. If the *F* test for a regression analysis was significant ($P<0.05$), pairwise comparisons were completed using the adjusted Wald test and a Bonferroni adjusted *P* value to identify significant differences among adjusted means in analyses of nutrient intakes or unadjusted means in analyses of BMIs and BMI *z* scores.

RESULTS

The analysis was based on dietary recalls collected from 7,557 children and adolescents. A total of 1,265 respondents were classified as flavored milk drinkers, 3,705 were classified as exclusively plain milk drinkers, and 2,587 were classified as nondrinkers of milk (Table 1). In each group, total milk intakes by flavored milk consumers were significantly greater than total milk intakes by consumers of exclusively plain milk, although intakes of plain milk by flavored milk drinkers were lower than intakes by exclusively plain milk drinkers. More than 95% of children and adolescents identified as flavored milk drinkers reported drinking ½ c or more of flavored milk on the day of recall, and 92% or more of children and adolescents identified as exclusively plain milk drinkers reported drinking at least ½ c plain milk (data not shown). In addition, 70% or more of the populations of flavored milk and exclusively plain milk drinkers consumed 1 c or more of flavored or plain milk, respectively (data not shown).

Energy

Mean energy intakes by milk consumers were significantly greater than energy intakes by milk nondrinkers for all groups except boys aged 6 to 11 years (Table 2). Among 2- to 5-year-olds, energy intakes by children who consumed flavored milk were greater than intakes by consumers of exclusively plain milk. Mean energy intakes were not different between consumers of flavored or exclusively plain milk in populations of 6- to 11-year-olds or 12- to 18-year-olds.

Nutrient Intakes, Unadjusted for Energy, Age, and Sex

Because there were significant differences in energy intakes among the three milk categories, the nutrient intake estimates presented (Tables 2 and 3) and discussed here are intake estimates adjusted for energy intake, age, and sex. The unadjusted means (data not shown) tended to show higher nutrient intakes by 2- to 5-year-old flavored milk drinkers compared with exclusively plain milk drinkers, possibly reflecting their higher energy intakes. Overall, differences among unadjusted mean nutrient intakes by milk drinking status of 6- to 11-year-olds and 12- to 18-year-olds were similar to differences based on the adjusted values. Notable differences between the unadjusted and adjusted mean nutrient intakes were seen only for total fat and added sugars. Unadjusted mean intakes of total fat by 2- to 5-year-olds in the flavored milk group were higher than intakes by exclusively plain milk drinkers and intakes by exclusively plain milk drinkers were higher than intakes by milk nondrinkers, again likely reflecting higher energy intakes by these groups. Unadjusted mean total fat intakes by older female (aged 6 to 11 and 12 to 18 years) consumers of flavored milk were comparable to intakes by exclusively plain milk drinkers, and higher than intakes by milk nondrinkers. Unadjusted mean added sugars intakes differed by milk drinking status only in the population of 2- to 5-year-olds; intakes were highest among flavored milk drinkers, lowest among exclusively plain milk drinkers, and intermediate among milk nondrinkers.

Nutrient Intakes, Adjusted for Energy Intakes, Age, and Sex

Macronutrients, Cholesterol, and Added Sugars. Drinkers of flavored milk and exclusively plain milk had comparable protein intakes on the day of recall, and these intakes were greater than those by milk nondrinkers for most groups (Table 2). Milk nondrinkers aged 2 to 5 years had higher fat intakes than milk drinkers, and nonmilk drinking males aged 12 to 18 years had higher fat intakes than exclusively plain milk drinkers. Except for girls aged 6 to 11 years, milk drinkers tended to have higher

Table 2. Mean unadjusted energy intakes and mean adjusted macronutrient and added sugars intakes by milk drinking status of children and adolescents aged 2 to 18 years (N=7,557), based on data from the 1999-2002 National Health and Nutrition Examination Surveys

	Intake[abc]		
Nutrient and population	**Flavored milk drinkers**	**Exclusively plain milk drinkers**	**Nondrinkers**
	← *mean±standard error* →		
Energy (unadjusted) (kcal/d)			
Children 2 to 5 y	1,830±35.6^{x}	1,630±23.0^{y}	1,385±54.4^{z}
Boys 6 to 11 y	2,200±76.9	2,135±67.1	2,068±97.5
Girls 6 to 11 y	2,046±86.4^{x}	1,864±33.7^{x}	1,705±51.6^{y}
Boys 12 to 18 y	2,825±131.8^{x}	2,699±51.0^{x}	2,449±51.9^{y}
Girls 12 to 18 y	2,248±92.4^{x}	2,077±32.9^{x}	1,837±47.1^{y}
Protein (g/d)			
Children 2 to 5 y	55.8±1.14^{x}	56.0±0.66^{x}	48.1±0.85^{y}
Boys 6 to 11 y	73.0±1.80^{x}	72.0±1.25^{xy}	64.7±2.55^{y}
Girls 6 to 11 y	62.7±1.43^{x}	63.9±0.79^{x}	55.9±1.27^{y}
Boys 12 to 18 y	97.1±2.18^{x}	92.6±1.26^{x}	86.1±1.95^{y}
Girls 12 to 18 y	67.4±2.22^{xy}	68.5±0.95^{x}	61.4±1.15^{y}
Total fat (g/d)			
Children 2 to 5 y	57.1±0.99^{y}	57.9±0.52^{y}	61.4±1.41^{x}
Boys 6 to 11 y	77.2±1.42	77.9±1.31	81.4±1.66
Girls 6 to 11 y	68.0±1.66	68.1±0.80	70.6±1.42
Boys 12 to 18 y	93.0±1.59^{xy}	93.3±1.11^{y}	96.6±1.25^{x}
Girls 12 to 18 y	72.±2.37	70.2±1.23	73.7±1.16
Total saturated fat (g/d)			
Children 2 to 5 y	22.1±0.56^{x}	21.3±0.27^{x}	19.6±0.55^{y}
Boys 6 to 11 y	28.8±0.45^{x}	27.9±0.49^{xy}	26.0±0.86^{y}
Girls 6 to 11 y	24.7±0.61	24.2±0.52	22.8±0.57
Boys 12 to 18 y	34.6±0.90^{x}	33.5±0.49^{x}	31.4±0.51^{y}
Girls 12 to 18 y	25.7±0.84^{xy}	25.3±0.41^{x}	23.9±0.36^{y}
Carbohydrate (g/d)			
Children 2 to 5 y	230±2.6	228±1.5	227±3.2
Boys 6 to 11 y	294±3.6	292±3.2	290±4.6
Girls 6 to 11 y	257±4.9	255±2.0	258±4.1
Boys 12 to 18 y	352±5.3	358±3.1	349±4.2
Girls 12 to 18 y	270±4.9	273±3.0	270±2.8
Added sugars (tsp/d)			
Children 2 to 5 y	17.8±0.67^{x}	15.8±0.48^{y}	18.8±0.82^{x}
Boys 6 to 11 y	24.7±0.69^{xy}	24.3±0.79^{y}	28.5±1.66^{x}
Girls 6 to 11 y	22.7±1.26	21.0±0.71	24.1±1.03
Boys 12 to 18 y	34.1±1.57	33.1±0.90	35.3±1.39
Girls 12 to 18 y	24.3±1.51^{xy}	23.5±0.59^{y}	28.0±0.73^{x}

[a]Means for energy were unadjusted; means for all other nutrients were adjusted on energy, age, and sex.
[b]Milk drinking status based on consumption of milk as a beverage or in ready-to-eat breakfast cereal; flavored milk drinkers may have consumed plain milk in addition to flavored milk.
[c]Different superscripts within a row (x,y) indicate statistically significant differences using a Bonferroni adjustment ($P<0.05$).

saturated fat intakes than nonmilk drinkers. No differences in cholesterol intake were observed by milk-drinking status (data not shown). Mean intake of total dietary carbohydrates did not differ among the three milk categories in any population group. Added sugars intakes were comparable for consumers of flavored milk and nondrinkers of milk. Added sugars intakes by exclusively plain milk drinkers were significantly lower than those by consumers of flavored milk and by milk nondrinkers aged 2 to 5 years. The added sugars intakes by boys aged 6 to 11 years and female respondents aged 12 to 18 years were lower for consumers of exclusively plain milk than for milk nondrinkers, but did not differ between the two groups of milk drinkers.

Minerals and Vitamin A. Intakes of calcium, phosphorus, magnesium, potassium, and vitamin A by milk drinkers were significantly higher than intakes of these nutrients by milk nondrinkers in every age–sex group (Table 3). Calcium intakes by flavored milk consumers were also higher than intakes by consumers of exclusively plain milk among boys aged 6 to 11 years, and phosphorus intakes by flavored milk drinkers were higher than those by consumers of exclusively plain milk among children aged 2 to 5 years and male respondents aged 12 to 18 years. Potassium intakes by flavored milk drinkers were higher than those by consumers of exclusively plain milk among boys aged 6 to 11 years and aged 12 to 18 years.

Table 3. Mean adjusted mineral and vitamin intakes by milk drinking status of children and adolescents aged 2 to 18 years (N=7,557), based on data from the 1999-2002 National Health and Nutrition Examination Surveys

Nutrient and population	Intake[abc]		
	Flavored milk drinkers	Exclusively plain milk drinkers	Nondrinkers
	← mean±standard error →		
Calcium (mg/d)			
Children 2 to 5 y	1,030±43.3[x]	925±24.9[x]	537±24.6[y]
Boys 6 to 11 y	1,224±40.8[x]	1,054±26.9[y]	622±31.2[z]
Girls 6 to 11 y	952±29.5[x]	928±24.9[x]	563±20.2[y]
Boys 12 to 18 y	1,372±48.2[x]	1,315±34.2[x]	760±17.7[y]
Girls 12 to 18 y	992±41.5[x]	1,038±22.5[x]	576±11.7[y]
Phosphorus (mg/d)			
Children 2 to 5 y	1,168±29.4[x]	1,084±17.3[y]	814±17.5[z]
Boys 6 to 11 y	1,426±29.5[x]	1,306±31.1[x]	1,034±36.5[y]
Girls 6 to 11 y	1,183±20.8[x]	1,168±18.5[x]	897±16.6[y]
Boys 12 to 18 y	1,762±28.4[x]	1,657±24.2[y]	1,309±16.5[z]
Girls 12 to 18 y	1,262±38.7[x]	1,259±17.7[x]	943±11.4[y]
Magnesium (mg/d)			
Children 2 to 5 y	206±4.2[x]	198±2.6[x]	167±4.4[y]
Boys 6 to 11 y	252±7.7[x]	234±5.5[x]	197±6.0[y]
Girls 6 to 11 y	206±4.4[x]	210±3.5[x]	185±4.3[y]
Boys 12 to 18 y	305±7.2[x]	292±4.6[x]	251±4.2[y]
Girls 12 to 18 y	235±8.5[x]	227±4.4[x]	189±2.8[y]
Potassium (mg/d)			
Children 2 to 5 y	2,216±44.5[x]	2,094±24.4[x]	1,664±38.1[y]
Boys 6 to 11 y	2,559±61.4[x]	2,326±52.8[y]	1,813±75.9[z]
Girls 6 to 11 y	2,186±64.0[x]	2,084±49.3[x]	1,792±53.6[y]
Boys 12 to 18 y	3,146±65.6[x]	2,884±57.3[y]	2,356±64.8[z]
Girls 12 to 18 y	2,384±76.9[x]	2,263±33.5[x]	1,831±33.4[y]
Vitamin A, RAE (μg/d)			
Children 2 to 5 y	566±27.0[x]	557±14.2[x]	378±30.8[y]
Boys 6 to 11 y	720±41.8[x]	706±20.2[x]	389±31.1[y]
Girls 6 to 11 y	582±55.5[x]	585±19.4[x]	420±23.3[y]
Boys 12 to 18 y	733±37.8[x]	807±27.9[x]	443±26.0[y]
Girls 12 to 18 y	641±63.4[x]	690±15.9[x]	355±24.2[y]

[a]Means were adjusted on energy, age, and sex.
[b]Milk drinking status based on consumption of milk as a beverage or in ready-to-eat breakfast cereal; flavored milk drinkers may have consumed plain milk in addition to flavored milk.
[c]Different superscripts within a row (x,y) indicate statistically significant differences using a Bonferroni adjustment ($P<0.05$).

BMI and BMI *z* Scores. BMI and BMI *z* scores did not differ by milk drinking status among children aged 2 to 5 years or 6 to 11 years; however, male milk nondrinkers aged 12 to 18 years had greater BMIs and BMI *z* scores compared to milk drinkers, and adolescent female milk nondrinkers had greater BMIs and BMI *z* scores compared to consumers of exclusively plain milk (Table 4).

DISCUSSION

Results of this study indicate that children and adolescents consuming flavored milk or exclusively plain milk have comparable nutrient intakes adjusted for energy, age and sex, and that their nutrient intakes tend to be superior to those of milk nondrinkers. It is important to note that only those children and adolescents who consumed milk had average calcium intakes close to their dietary recommended intakes (40).

Adjusted intakes of potassium, calcium, and phosphorus were higher among flavored milk drinkers than among exclusively plain milk drinkers in some age–sex groups.

Johnson and colleagues (19) reported higher total milk intakes (adjusted for total energy intake, age, sex, and race) by flavored milk consumers vs nonconsumers. In that study, flavored milk consumers also were found to have lower intakes of soft drinks and fruit drinks than nonconsumers of flavored milk. Their findings indicate that children and adolescents who drink flavored milk may elect to drink milk (either flavored or plain) in place of other less nutritious sweetened beverages that are high in added sugars. Other research has shown that milk drinkers who also drink sodas consume less milk and milk drinks than milk drinkers who do not drink sodas (8), and that sodas and other sweetened drinks tend to displace milk in the diets of some children and adolescents as they mature (41). Sweetened beverages including soda and fruit drinks are a significant source of added sugars in the diets of children and adolescents, accounting for 50% or more of total added sugars intakes by adolescents; these beverages are the number-one source of energy in teen diets (6,42).

Table 4. Mean body mass index (BMI) and BMI *z* score by milk drinking status of children and adolescents aged 2 to 18 years (N=7,557), based on data from the 1999-2002 National Health and Nutrition Examination Surveys

	Milk Drinking Status[a]					
	Flavored Milk Drinkers		Exclusively Plain Milk Drinkers		Nondrinkers	
Body measure and population	n	Mean±SE[b]	n	Mean±SE	n	Mean±SE
BMI						
Children 2 to 5 y	271	16.4±0.21	888	16.2±0.08	221	16.0±0.15
Boys 6 to 11 y	263	18.4±0.24	537	18.0±0.23	249	19.0±0.40
Girls 6 to 11 y	232	18.6±0.54	525	18.1±0.22	264	18.7±0.47
Boys 12 to 18 y	254	21.8±0.37^{y}	884	22.3±0.23^{y}	836	23.7±0.26^{x}
Girls 12 to 18 y	194	22.7±0.55^{xy}	748	22.2±0.23^{y}	978	23.8±0.28^{x}
BMI *z* score						
Children 2 to 5 y	271	0.36±0.113	888	0.21±0.048	221	0.16±0.092
Boys 6 to 11 y	263	0.63±0.104	537	0.41±0.076	249	0.52±0.093
Girls 6 to 11 y	232	0.48±0.155	525	0.39±0.070	264	0.43±0.115
Boys 12 to 18 y	254	0.27±0.114^{y}	884	0.35±0.053^{y}	836	0.59±0.052^{x}
Girls 12 to 18 y	194	0.60±0.102^{xy}	748	0.35±0.055^{y}	978	0.57±0.050^{x}

[a]Milk drinking status based on consumption of milk as a beverage or in ready-to-eat breakfast cereal; flavored milk drinkers may have consumed plain milk in addition to flavored milk. Different superscripts (x,y) within a row indicate statistically significant differences using a Bonferroni adjustment ($P<0.05$).
[b]SE=standard error.

In this study, adjusted intakes of added sugars were comparable between flavored milk drinkers and nonmilk consumers, and were significantly higher than intakes by exclusively plain milk consumers only among young children. These findings suggest that inclusion of flavored milk in the diet does not lead to significantly higher added sugars intakes by school-aged children and adolescents.

Among 2- to 5-year-olds, unadjusted energy intakes of flavored milk drinkers were higher than energy intakes by both exclusively plain milk drinkers and nondrinkers of milk. Among older children and adolescents, energy intakes by flavored milk drinkers were not significantly different from energy intakes by exclusively plain milk drinkers. The Dietary Guidelines for Americans encourage consumption of fat-free or low-fat dairy products instead of whole or reduced-fat products by people older than age 2 years (14), and increased access to nonfat or low-fat flavored milks prepared with less added sugars than traditional flavored milks would add less energy to the diets of children who prefer flavored milk to plain milk. Results from a 2005 survey conducted by the School Nutrition Association, the Child Nutrition Foundation, and the National Dairy Council on the availability of flavored milk in schools indicate that low-fat flavored milks were most commonly offered, and a majority of schools were interested in offering flavored milks with reduced sugar levels (43). The data used in this analysis are from the period 1999-2002, and may not reflect the most recent trends in milk consumption patterns. In the study populations of school-aged children and adolescents, 45% to 55% of flavored milk drinkers did not specify the fat content of flavored milk, and approximately 20% to 30% of people in each group reported drinking whole milk-based flavored milk (data not shown, based on unweighted data). These findings suggest that school-aged children and adolescents may not be able to recall the specific fat content of the milk they report consuming. More than 50% of flavored milk drinkers aged 2 to 5 years consumed a whole milk-based flavored milk; these preschool-aged children likely consumed flavored milk at home or in daycare settings.

Data suggest that school-aged children's access to flavored milk in school may help to promote milk consumption. Results from a study in schools show that students purchase more milk when fluid milk offerings are enhanced and include the option of flavored milks (16). We are unaware of any research on the influence that access to flavored milk in childhood may have on preferences for other sweet foods or plain milk.

Findings from this analysis show that mean BMIs and BMI *z* scores do not significantly differ among children aged 2 to 5 years or 6 to 11 years by milk drinking status based on a single day of recall. In the populations of 12- to 18-year-old boys and girls, mean BMIs and BMI *z* scores among milk drinkers were comparable to or lower than mean measures among nondrinkers of milk. Findings from this study therefore suggest that milk drinkers—either of flavored milk or of exclusively plain milk—are not likely to have higher body BMIs or BMI *z* scores than children or adolescents who do not drink milk.

There is a growing body of literature on milk or dairy consumption—which typically includes flavored milk—and body measures, but investigations specifically on flavored milk consumption and body measures were not identified. In a cross-sectional study of beverage patterns and BMI based on nationwide food consumption data in the United States, BMI of girls was found to be negatively correlated with milk consumption; however, no correlation between milk consumption and BMI of boys was observed (44). In a study of Italian children aged 3 to 11 years, milk consumption was inversely associated with age- and sex-specific BMI *z* scores (29).

A number of longitudinal studies have failed to find associations between intakes of milk or dairy products and changes in body measures (26,27), or changes in energy-adjusted BMI gains (45). Results of some longitudinal studies have shown inverse relationships between dairy intakes and body measures. Moore and colleagues (28), for example, found that adjusted BMI and body fat measures of 90 children aged 10 to 13 years were inversely related to dairy consumption at ages 3 through 5 years, suggesting that low consumption of dairy products at a young age places children at greater risk for excessive body fat gains in later years.

Findings from this study suggest that diets that include flavored milk are not associated with adverse effects on body measures as indicated by mean BMI or BMI *z* score. However, the goal of this research was not to assess relationships between the amount of milk consumed and body measures, but rather to determine if there are relationships among BMI and diets that include flavored milk or exclusively plain milk or no milk beverages.

An important strength of this study is that identification of flavored milk consumers was based on all reported intakes of flavored milk beverages or flavored milk beverage combinations. Through review of all beverage combinations, intakes of flavored milk that otherwise would have been misclassified as plain milk were identified. In addition, the estimates were developed from a large sample that is representative of the US population of children and adolescents.

Some limitations of the current analysis should be considered when interpreting the data. First, the analysis was based on a single 24-hour dietary recall, and it is unknown how representative these patterns of consumption are of usual intakes. An additional limitation may be underreporting during the dietary recall (46). Underreporting may be more prevalent among heavier children than lean children (47), which may have implications for the analysis of BMI by milk drinking status. In addition, foods and beverages such as soft drinks that may be perceived as "bad" foods are more likely to be underreported while foods and beverages perceived as "good" foods such as milk are less likely to be underreported (48). Furthermore, associations between milk drinking status and body measures cannot be attributed solely to milk consumption.

It is important to note that the milk drinking classifications in this study are based only on reported intakes of milk in beverages or with ready-to-eat cereals. Contributions from milk consumed in food mixtures such as cream soups or puddings were not considered when making the classifications. Intake of cheese, yogurt, and other dairy products that, like milk, are concentrated sources of potassium, calcium, phosphorus, and other nutrients were not examined (1,3,49). It is also important to recognize that the category of flavored milk drinkers includes children and adolescents who may have consumed plain milk as well as flavored milk; therefore, total nutrient intakes reflect contributions from both types of milk. Energy and added sugars intakes by children consuming both flavored and plain milk are potentially lower than intakes by children consuming comparable total amounts of flavored milk. In another study of flavored milk intakes by children and adolescents no difference in added sugars intakes adjusted for energy, age, sex, and race was seen between people who consumed an average of 1 c or less of flavored milk per day vs those who consumed an average of more than 1 c (19).

Adjusted nutrient intakes were similar between flavored milk drinkers and drinkers of exclusively plain milk. These findings suggest that consumption of either flavored or plain milk has a positive influence on nutrient intakes by children and adolescents, and is not associated with adverse effects on BMI or BMI *z* score. Many children and adolescents fall short of the recommended daily intake of two servings of milk or equivalent dairy products for children aged 2 to 8 years, and three dairy servings per day for people aged 9 years and older (14,15). Access to low-fat or nonfat flavored milk could help children and adolescents meet the recommended intakes of dairy servings. Research is needed to determine the specific effects of flavored milk consumption on preferences for sweetened products, obesity, calcium intakes, and bone health. Until those data are available, limiting children and adolescents' access to flavored milk due to its higher added sugars or energy content may only have the undesirable effect of further reducing intakes of many essential nutrients provided by milk.

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