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Research Article

Is Flavored Milk Really a Bad Beverage Choice? The Nutritional Benefits of Flavored Milk Outweigh the Added Sugars Content

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Abstract

The objective of this study was to re-examine the nutritional contribution of flavored milk in the diets of children with an emphasis on total milk consumption, added sugars, and the shortfall nutrients of public health concern using the most recent national data set available. Intake data from children 2 to 18 years (N = 28,259) participating in the NHANES 2001-2018 were obtained from the 24- hour dietary recall interviews. Mean nutrient intakes, nutrient adequacy, least square means and standard errors of energy and intakes of each nutrient were determined. Z-scores were used to assess population differences in nutrient adequacy. A conservative p-value of ($p \leq 0.001$) was used. Compared with non-consumers, consumers of flavored milk had higher intakes of total energy, total sugars, and total added sugars. Consumers of flavored milk consumed more total milk (approximately 1-cup equivalent more) than non-consumers. Flavored milk consumers 2-to-18 years, had significantly ($p < 0.0001$) higher intakes of fiber, vitamins D, A and B-12, riboflavin, calcium, potassium, magnesium and phosphorus than non-consumers. Compared to non-consumers, consumers of flavored milk had a lower percentage not meeting dietary recommendations for vitamins A, D, and B-12, riboflavin, calcium, magnesium, and phosphorus. The percentage of flavored milk consumers with intakes above the AI was lower for fiber intake but higher for potassium intake compared to non-consumers. Based on data from this study, flavored milk is not a bad beverage of choice. The nutritional benefits of flavored milk far outweighs the added sugars content.

Keywords: Flavored Milk; Added Sugars Intake; Nutrient Intake; Nutrient Adequacy; Child Nutrition; NHANES

Abbreviations

AI: Adequate Intake; ARS: Agricultural Research Service; DGA: Dietary Guidelines for Americans; DGAC: Dietary Guidelines Advisory Committee; EAR: Estimated Average Requirement; NCI: National Cancer Institute; NHANES: National Health and Nutrition Examination Survey; PIR: Poverty Income Ratio; SAS: Statistical Analysis System; SE: Standard Error; UI: Usual Intake; U.S: United States; USDA: United States Department of Agriculture

Introduction

The 2020 Dietary Guidelines Advisory Committee [1] recognized calcium, potassium, vitamin D, and dietary fiber as nutrients of public health concern because low intakes were associated with adverse health outcomes [1]. Other nutrients including vitamins C, A, K and E, choline and magnesium were identified as being underconsumed by the US population [1]. For decades, milk has been recognized to provide shortfall nutrients to the diets of children [2-10]. Intakes of vitamins A and D, riboflavin, potassium, magnesium, folate and calcium improved as dairy products increased in the diet [2-10]. To help address the low intake of nutrients of public health concern, the 2020 Dietary Guidelines for Americans recommend 2.5 servings of dairy products for children 4-8 years of age and three servings for those 9-18 years of age [1].

Despite the significant nutritional contribution of dairy products in the diet, 63% of the population 2 years of age and older

were below the calcium intake recommendation. The percentage of the population with intakes below recommended levels for magnesium was 57%, 6% for phosphorus, 4% for riboflavin, 51% for vitamin A, 6% for vitamin B-12 and 99% for vitamin D [11]. Currently the percentage of the population above the recommended Adequate Intake (AI) is 21% for potassium and 4% for dietary fiber [11-13]. Further, only about one-fourth of children 2-18 years consumed the recommended number of daily dairy servings [11] with more than 60% of total dairy servings consumed by children as fluid milk [14]. However, consumption of milk decreases with age [15].

Flavored milk is a viable option for getting closer to meeting the recommended intakes of dairy products and selected nutrients [2,5-8,16-18]. Sixty-eight percent of all milk available in schools is flavored [19,20], with the majority being chocolate milk. Previous studies have shown that children who consumed flavored milk consumed more total milk and had higher intakes of nutrients, specifically calcium, phosphorus, magnesium, potassium, vitamins A and D [2,5-8,16,17]. Despite the nutritional benefits of flavored milk, some school districts are removing flavored milk from the lunchrooms. Several studies have reported on potential unintended nutritional consequences of removing flavored milk from the lunchrooms [21-24]. The predominant unintended consequence of removing flavored milk from the lunchrooms was a decrease in total milk consumption [21-24] which could negatively impact nutrient intake. Thus, consumption of flavored milk may increase nutritional benefits because more children will likely meet the recommended daily servings of milk.

There is no clear consensus in the medical and nutrition community to settle the debate on banning flavored milk from the lunchrooms given the perception that flavored milk will have a negative impact on the overall quality of children's diets, specifically with regard to the amount of added sugars in flavored milk [25-27]. However, flavored milk accounts for only 4% of total added sugars on a per capita basis and provides nine essential nutrients in the diets of children [6]. Given the open debate, it is important that studies be conducted with more recent data looking at the nutritional contribution of flavored milk in the diets of children. This is especially important given that the 2020 DGAC revisited the added sugars recommendation and concluded that the recommendation for added sugars of less than 10% of total energy [28], should be lowered to 6% of total energy in an effort to mitigate cardiovascular disease and obesity [1]. It is critical to understand the nutritional contribution of flavored milk in the diets of children in light of the new added sugars recommendation balanced with its positive contribution to the nutrients of public health concern. The objective of this study was to re-examine the nutritional contribution of flavored milk in the diets of children with an emphasis on total milk consumption, added sugars, and the shortfall nutrients of public health concern using the most recent national data set available.

Materials and Methods

Population and dietary intake

Detailed information about the design, questionnaires, and examination methodology of the National Health and Nutrition Examination Survey (NHANES) has been described previously [29]. Intake data from children 2 to 18 years (N = 28,259) participating in the NHANES 2001-2018 were obtained from the 24- hour dietary recall interviews using an automated multiple-pass method [30,31]. Two 24-hour dietary recalls were collected: the first recall was in person in the Mobile Examination Center and the second recall was over the telephone. Data judged incomplete or unreliable by the National Center for Health Statistics staff were excluded from the national public data set prior to analyses. Participants 12 years of age and older completed their own dietary interview; children 6 to 11 years were assisted by an adult; and parents/guardians reported for children younger than 6 years. Detailed description of the dietary interview method [32] has been detailed elsewhere.

Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Predominate forms of flavored milk were various forms of chocolate milk such as whole, 2%, and low fat, cocoa and sugar or chocolate syrup added to various forms of milk. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall. Cup equivalents of total flavored milk intake were determined using the MyPyramid Equivalent Databases and the more recent Food Patterns Equivalent Databases, as appropriate [33,34]. The nutrients of public health concern [35] (dietary fiber, vitamin D, calcium, and potassium) and one nutrient to limit (added sugars) [35], were specifically selected for analysis. Other nutrients provided in milk, specifically riboflavin, vitamins A and B-12, magnesium, and phosphorus were also included.

Mean nutrient intakes were determined using the Day one dietary recall data. For nutrient adequacy the two dietary recalls and the National Cancer Institute (NCI) (version 2.1) [36,37] usual intake (UI) programs were used for the estimation of UI in order to estimate long term mean intakes for energy and nutrients of interest. Given that most nutrients are typically consumed almost every day, only the amount portion of the NCI program was used (thus the probability of consumption component of the NCI program was not used). The NCI method allows for a Box- Cox transformation of the nutrient/food intake to account for non-normality and uses a measurement error model with covariates using a within subject and a between subject error structure. The measurement error model contained covariates for weekend (Friday- Sunday) versus weekday (Monday-Thursday) of recall, recall day sequence (day 1 or day 2) and age groups.

Statistical analyses

Analyses were conducted using SAS 9.4 [38]. Appropriate weighting factors were used in analyses to adjust for oversampling of selected groups, survey nonresponse of some individuals, and day of the week that the interview was conducted [39]. We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR). We assessed whether there were changes in total milk, flavored milk, energy, and nutrients over time using regression analyses with NHANES cycles as time variable. To assess inadequate intake, the Estimated Average Requirements (EAR) cut point method was used [40]; for nutrients without an EAR, % above Adequate Intake (AI) was used [40]. Z-scores were used to assess population differences in nutrient adequacy and % above AI. Instead of making a Bonferroni adjustment for multiple comparisons, we used a conservative p-value for the statistical significance of all statistical tests ($p \leq 0.001$). However, to ensure transparency all p-values are reported.

Results and Discussion

Sample demographics **(Table 1)**

Demographic variables	Total		Non-consumers (N, %)		Consumers (N, %)		P value[3]
	Mean	SE	Mean	SE	Mean	SE	
Sample (N)	28,259		23,510		4,749		
Age (mean)	10.08	0.06	10.38	0.06	8.78	0.10	<0.0001
Gender (male %)	50.74	0.49	49.67	0.52	55.40	1.13	<0.0001
Ethnicity (%)							
Mexican American	14.44	0.88	13.93	0.87	16.71	1.18	0.0007
Other Hispanic	6.56	0.50	6.43	0.51	7.11	0.63	0.1641
Non-Hispanic-White	56.62	1.41	56.89	1.39	55.43	1.97	0.3003
Non-Hispanic-Black	14.10	0.80	14.42	0.84	12.70	0.94	0.0357
Poverty Income Ratio (PIR, %)							
< 1.35	33.95	0.93	32.86	0.94	38.75	1.47	<0.0001
1.35< = 1.85	10.98	0.43	10.78	0.44	11.82	0.87	0.2407
PIR> 1.85	55.07	1.04	56.36	1.07	49.43	1.65	<0.0001
Total energy intake (KJ)	8146	8.50	8058	8.86	8540	15.16	<0.0001
Total sugars (g)	127	0.75	123.71	0.79	142	1.28	<0.0001
Added sugars (tsp eq)	19.14	0.16	18.90	0.18	20.20	0.27	<0.0001
Total milk (C eq)	1.34	0.02	1.17	0.02	2.08	0.03	<0.0001
Flavored milk (C eq)	0.23	0.01	0.00	0.00	1.22	0.02	<0.0001

Energy (kJ) from flavored milk	183	1.37	0.00	0.00	987	3.91	<0.0001
% of total energy from flavored milk	9.00	0.07	0.00	0.00	48.00	0.18	<0.0001
Total sugars from flavored milk (g)	5.95	0.18	0.00	0.00	31.99	0.53	<0.0001
% total sugars intake from flavored milk	4.68	0.14	0.00	0.00	22.55	0.32	<0.0001
Total added sugars from flavored milk (tsp eq)	0.72	0.02	0.00	0.00	3.88	0.07	<0.0001
% added sugars intake from flavored milk	3.77	0.11	0.00	0.00	19.19	0.35	<0.0001

Table 1: Demographics of the sample for children 2 to 18 years by flavored milk consumption: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Significance was defined as $p \leq 0.001$.

Demographics for the sample of 2-18 years are presented in table 1. Demographics of the sample by specific age groups are presented in supplemental tables 1 to 5. Compared with non-consumers (N = 23,510), consumers (N = 4,749) of flavored milk were younger ($p < 0.0001$), more likely to be males ($p < 0.0001$), Mexican American ($p = 0.0007$), and reported a PIR <1.35 ($p < 0.0001$). In contrast, the percentage consuming flavored milk was in those with a PIR > 1.85 ($p < 0.0001$) compared to non-consumers.

Demographic variables	**Total (N: 4,770)**		**Non-consumers (N: 4,630, 96.8%)**		**Consumers (N: 170, 3.2%)**		**P value[3]**
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	
Age (mean)	0.58	0.01	0.57	0.01	0.91	0.03	<0.0001
Gender (male %)	51.34	0.96	51.13	0.97	57.87	5.94	0.2643
Ethnicity (%)							
Mexican American	16.95	1.20	16.93	1.21	17.74	3.46	0.8123
Other Hispanic	7.62	0.69	7.56	0.71	9.60	2.93	0.4962
Non-Hispanic-White	52.92	1.81	52.86	1.83	54.62	5.92	0.7663
Non-Hispanic-Black	14.70	0.99	14.86	1.02	9.84	2.37	0.0515
Other	7.80	0.58	7.79	0.56	8.20	3.86	0.9141
Poverty Income Ratio (PIR, %)							
< 1.35	43.01	1.09	42.89	1.10	46.68	5.88	0.5228
1.35<= 1.85	10.61	0.65	10.40	0.64	16.97	5.21	0.2105
PIR> 1.85	46.39	1.26	46.70	1.26	36.35	6.52	0.1150

Total energy intake (KJ)	4569	11.21	4506	11.20	6406	52.07	<0.0001
Total sugars (g)	87.76	0.96	86.50	0.94	126.24	4.93	<0.0001
Added sugars (tsp eq)	4.58	0.14	4.33	0.13	12.22	0.75	<0.0001
Total milk (C eq)	1.40	0.04	1.36	0.04	2.67	0.18	<0.0001
Flavored milk (C eq)	0.04	0.01	0.00	0.00	1.35	0.13	<0.0001
Energy (KJ) from flavored milk	38	1.36	0.00	0.00	1192	27.63	<0.0001
% of total energy from flavored milk	0.83	0.12	0.00	0.00	18.64	1.73	<0.0001
Total sugars from flavored milk (g)	1.20	0.17	0.00	0.00	37.77	3.53	<0.0001
% total sugars intake from flavored milk	1.37	0.19	0.00	0.00	29.92	2.70	<0.0001
Total added sugars from flavored milk (tsp eq)	0.16	0.02	0.00	0.00	4.93	0.47	<0.0001
% added sugars intake from flavored milk	3.42	0.46	0.00	0.00	40.37	3.43	<0.0001

Supplemental Table 1: Demographics of the sample for children <2 years by flavored milk consumption: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Significance was defined as $p \leq 0.001$.

Demographic variables	**Total (N: 3,864)**		**Non-consumers (N: 3,309, 84.5%)**		**Consumers (N: 555, 15.5%)**		**P value[3]**
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	
Age (mean)	2.48	0.01	2.47	0.01	2.52	0.03	0.1639
Gender (male %)	50.24	1.13	49.54	1.24	54.08	3.31	0.2104
Ethnicity (%)							
Mexican American	16.19	1.12	15.79	1.11	18.40	2.47	0.2739
Other Hispanic	7.54	0.68	7.51	0.70	7.75	1.31	0.8518
Non-Hispanic-White	53.49	1.82	52.57	1.92	58.46	3.33	0.0833
Non-Hispanic-Black	14.02	0.96	14.88	1.10	9.36	1.28	0.0007
Other	8.76	0.65	9.26	0.70	6.03	1.06	0.0047
Poverty Income Ratio (PIR, %)							
< 1.35	38.53	1.36	38.66	1.40	37.80	3.06	0.7812
1.35<= 1.85	11.41	0.69	11.31	0.75	11.95	2.04	0.7740
PIR> 1.85	50.06	1.49	50.02	1.54	50.25	3.32	0.9475
Total energy intake (KJ)	6150	10.56	6008	11.14	6912	32.62	<0.0001
Total sugars (g)	105.48	1.10	100.48	1.02	132.70	3.11	<0.0001

Added sugars (tsp eq)	11.06	0.18	10.19	0.18	15.75	0.46	<0.0001
Total milk (C eq)	1.67	0.03	1.56	0.03	2.30	0.07	<0.0001
Flavored milk (C eq)	0.21	0.02	0.00	0.00	1.36	0.06	<0.0001
Energy (KJ) from flavored milk	181	3.10	0.00	0.00	1172	12.73	<0.0001
% of total energy from flavored milk	2.95	0.21	0.00	0.00	16.93	0.76	<0.0001
Total sugars from flavored milk (g)	5.98	0.45	0.00	0.00	38.59	1.81	<0.0001
% total sugars intake from flavored milk	5.67	0.40	0.00	0.00	29.08	1.16	<0.0001
Total added sugars from flavored milk (tsp eq)	0.78	0.06	0.00	0.00	5.05	0.25	<0.0001
% added sugars intake from flavored milk	7.09	0.52	0.00	0.00	32.09	1.39	<0.0001

Supplemental Table 2: Demographics of the sample for children 2 to 3 years by flavored milk consumption: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Significance was defined as p≤0.001.

Demographic variables	**Total (N: 7,762)**		**Non-consumers (N: 5,845, 72.5%)**		**Consumers (N: 1,917, 27.5%)**		**P value[3]**
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	
Age (mean)	6.05	0.02	6.00	0.03	6.18	0.04	0.0005
Gender (male %)	51.63	0.77	50.11	0.94	55.61	1.63	0.0060
Ethnicity (%)							
Mexican American	15.14	1.04	14.53	1.05	16.75	1.42	0.0575
Other Hispanic	6.55	0.54	6.50	0.57	6.69	0.75	0.7862
Non-Hispanic-White	55.92	1.73	55.46	1.74	57.14	2.37	0.3881
Non-Hispanic-Black	13.92	0.91	14.50	0.97	12.39	1.14	0.0447
Other	8.47	0.54	9.02	0.65	7.03	0.84	0.0527
Poverty Income Ratio (PIR, %)							
< 1.35	36.35	1.22	35.66	1.30	38.16	1.85	0.1761
1.35<= 1.85	11.03	0.64	10.92	0.68	11.34	1.36	0.7744
PIR> 1.85	52.62	1.35	53.43	1.45	50.50	2.24	0.2097
Total energy intake (KJ)	7494	9.84	7280	10.34	8050	20.62	<0.0001
Total sugars (g)	121	0.97	114	1.00	138	1.73	<0.0001
Added sugars (tsp eq)	16.89	0.19	15.99	0.21	19.25	0.35	<0.0001
Total milk (C eq)	1.45	0.02	1.21	0.02	2.08	0.04	<0.0001

Flavored milk (C eq)	0.33	0.01	0.00	0.00	1.20	0.03	<0.0001
Energy (KJ) from flavored milk	266	2.55	0.00	0.00	965	5.17	<0.0001
% of total energy	3.55	0.14	0.00	0.00	11.99	0.27	<0.0001
Total sugars from flavored milk (g)	8.56	0.34	0.00	0.00	31.08	0.69	<0.0001
% total sugars intake	7.08	0.27	0.00	0.00	22.45	0.47	<0.0001
Total added sugars from flavored milk (tsp eq)	1.03	0.04	0.00	0.00	3.75	0.09	<0.0001
% added sugars intake from flavored milk	6.11	0.24	0.00	0.00	19.46	0.52	<0.0001

Supplemental Table 3: Demographics of the sample for children 4 to 8 years by flavored milk consumption: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Significance was defined as $p \leq 0.001$.

Demographic variables	**Total (N: 8,117)**		**Non-consumers (N: 6,578, 79.7%)**		**Consumers (N: 1,539, 20.3%)**		**P value[3]**
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	
Age (mean)	11.01	0.02	11.08	0.03	10.73	0.05	<0.0001
Gender (male %)	50.24	0.88	49.31	0.92	53.90	2.08	0.0406
Ethnicity (%)							
Mexican American	14.12	0.97	13.27	0.98	17.49	1.43	0.0007
Other Hispanic	6.78	0.62	6.63	0.68	7.37	0.94	0.4645
Non-Hispanic-White	56.28	1.56	57.56	1.59	51.22	2.53	0.0080
Non-Hispanic-Black	14.35	0.87	14.46	0.91	13.93	1.28	0.6588
Other	8.47	0.59	8.08	0.64	9.99	1.24	0.1540
Poverty Income Ratio (PIR, %)							
< 1.35	32.43	1.17	30.15	1.18	41.53	2.41	<0.0001
1.35<= 1.85	11.50	0.58	11.39	0.60	11.96	1.26	0.6551
PIR> 1.85	56.07	1.30	58.47	1.33	46.51	2.63	<0.0001
Total energy intake (KJ)	8473	14.05	8314	15.70	9088	26.97	<0.0001
Total sugars (g)	129	1.24	125	1.38	143	2.58	<0.0001
Added sugars (tsp eq)	20.17	0.25	19.95	0.28	21.04	0.53	0.0743
Total milk (C eq)	1.31	0.03	1.14	0.03	2.00	0.05	<0.0001
Flavored milk (C eq)	0.24	0.01	0.00	0.00	1.16	0.03	<0.0001
Energy (KJ) from flavored milk	187	1.91	0.00	0.00	920	6.01	<0.0001

% of total energy from flavored milk	2.20	0.09	0.00	0.00	10.13	0.25	<0.0001
Total sugars from flavored milk (g)	6.04	0.25	0.00	0.00	29.77	0.80	<0.0001
% total sugars intake from flavored milk	4.69	0.19	0.00	0.00	20.75	0.44	<0.0001
Total added sugars from flavored milk (tsp eq)	0.71	0.03	0.00	0.00	3.51	0.10	<0.0001
% added sugars intake from flavored milk	3.53	0.15	0.00	0.00	16.71	0.45	<0.0001

Supplemental Table 4: Demographics of the sample for children 9 to 13 years by flavored milk consumption: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Significance was defined as $p \leq 0.001$.

Demographic variables	**Total (N: 8,516)**		**Non-consumers (N: 7,738, 90.2%)**		**Consumers (N: 738, 9.8%)**		**P value[3]**
	Mean	**SE**	**Mean**	**SE**	**Mean**	**SE**	
Age (mean)	15.97	0.02	16.00	0.02	15.67	0.07	<0.0001
Gender (male %)	50.57	0.84	49.69	0.88	58.69	2.85	0.0031
Ethnicity (%)							
Mexican American	13.42	0.95	13.36	0.93	14.02	1.83	0.6610
Other Hispanic	5.96	0.55	5.81	0.55	7.33	1.16	0.1567
Non-Hispanic-White	58.81	1.54	58.96	1.53	57.44	2.99	0.5663
Non-Hispanic-Black	14.05	0.87	14.15	0.91	13.15	1.64	0.5652
Other	7.76	0.53	7.73	0.56	8.06	1.49	0.8300
Poverty Income Ratio (PIR, %)							
< 1.35	31.36	1.15	30.92	1.18	35.39	2.52	0.0768
1.35<= 1.85	10.24	0.68	9.96	0.69	12.77	1.72	0.1028
PIR> 1.85	58.40	1.25	59.12	1.30	51.84	2.76	0.0111
Total energy intake (KJ)	9230	17.86	9171	18.22	9749	54.04	0.0139
Total sugars (g)	140	1.43	138	1.50	154	4.06	0.0005
Added sugars (tsp eq)	23.42	0.30	23.37	0.32	23.82	0.86	0.6231
Total milk (C eq)	1.13	0.03	1.02	0.03	2.11	0.08	<0.0001
Flavored milk (C eq)	0.13	0.01	0.00	0.00	1.32	0.05	<0.0001
Energy (KJ) from Flavored milk	103	1.80	0.00	0.00	1059	10.56	<0.0001
% of total energy from flavored milk	1.12	0.08	0.00	0.00	10.87	0.46	<0.0001
Total sugars from flavored milk (g)	3.39	0.24	0.00	0.00	34.75	1.38	<0.0001

% total sugars intake from flavored milk	2.43	0.17	0.00	0.00	22.67	0.87	<0.0001
Total added sugars from flavored milk (tsp eq)	0.41	0.03	0.00	0.00	4.22	0.19	<0.0001
% added sugars intake from flavored milk	1.76	0.13	0.00	0.00	17.71	0.87	<0.0001

Supplemental Table 5: Demographics of the sample for children 14 to 18 years by flavored milk consumption: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Significance was defined as $p \leq 0.001$.

Compared with non-consumers, consumers of flavored milk had higher total energy intake (kilojoule (kJ)), total sugars intake, and total added sugars intake (all significant at $p < 0.0001$). Consumers of flavored milk consumed more total milk (approximately 1-cup equivalent more) then non-consumers.

Specifically for flavored milk consumers, total energy from flavored milk was 987; accounting for 12% of total daily energy consumed. Total sugars consumed from flavored milk was 32 g; accounting for 23% of total daily amount of total sugars consumed. Total added sugars consumed from flavored milk was 3.9 tsp equivalents; accounting for 19% of total daily amount of added sugars in consumers only. However, on a population basis, the average per capita mean amount of added sugars was only 3.8% of total energy.

Secular trends (2001-2018) in milk consumption and selected nutrient intakes **(Supplemental Table 6)**

Variables	Survey Years																			
	2001-2002		2003-2004		2005-2006		2007-2008		2009-2010		2011-2012		2013-2014		2015-2016		2017-2018		Linear Trend	
	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	LSM	SE	β[3]	P value[4]
Total milk (C eq)	1.58	0.06	1.55	0.07	1.41	0.05	1.34	0.04	1.42	0.04	1.38	0.05	1.23	0.03	1.14	0.04	1.02	0.02	-0.03	<0.0001
Flavored milk (C eq)	0.24	0.02	0.24	0.02	0.20	0.02	0.25	0.02	0.28	0.02	0.22	0.02	0.20	0.02	0.22	0.02	0.20	0.02	0.00	0.2218
Total energy (KJ)	8498	22	8803	19	8464	26	7966	21	7954	23	8159	20	7786	22	7820	25	7916	18	-13	<0.0001
Added sugars (tsp eq)	22.30	0.32	22.81	0.60	21.15	0.59	19.68	0.38	18.82	0.41	18.87	0.36	16.74	0.39	16.16	0.41	16.87	0.36	-0.43	<0.0001
Fiber (g)	12.55	0.22	12.79	0.24	12.81	0.20	12.64	0.33	13.61	0.24	14.25	0.19	13.79	0.23	14.01	0.22	14.08	0.27	0.11	<0.0001
Vitamin D (µg)	6.41	0.19	6.18	0.21	5.68	0.17	5.31	0.13	5.96	0.12	5.98	0.16	5.32	0.12	5.40	0.20	4.72	0.10	-0.08	<0.0001

Vitamin A (RE)	588	19	556	22	581	14	590	16	587	13	603	11	593	13	594	18	593	14	1.5	0.1891
Vitamin B-12 (mcg)	5.15	0.13	5.27	0.14	5.20	0.15	4.99	0.10	4.79	0.08	4.91	0.12	4.67	0.11	4.58	0.12	4.34	0.10	-0.05	<0.0001
Riboflavin (mg)	2.16	0.05	2.24	0.04	2.15	0.04	2.03	0.04	1.94	0.04	1.96	0.02	1.97	0.03	1.92	0.04	1.79	0.02	-0.02	<0.0001
Calcium (mg)	978	25	1024	24	992	18	982	20	1058	17	1073	17	1019	21	987	25	975	15	0.2	0.8910
Magnesium (mg)	226	4	231	3	229	3	223	4	236	3	240	3	232	3	231	4	232	3	0.4	0.0901
Potassium (mg)	2257	46	2318	51	2206	39	2109	42	2218	34	2248	29	2143	29	2090	31	2087	32	-11	<0.0001
Phosphorus (mg)	1247	22	1283	22	1237	18	1201	18	1288	21	1300	15	1263	19	1240	23	1240	19	-0.03	0.9845

Supplemental Table 6: Secular trends in milk consumption and selected nutrients for children 2-18 years: NHANES* (2001-2018)[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018, LSM: Least square mean, SE: Standard error, KJ: Kilojoule.

[1]We determined the LSM and SE of milk consumption and intakes of energy and each nutrient. Linear trend analyses was conducted

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Beta is the regression coefficient of difference between non0consumers and consumers.

[4]Significance was defined as $p \leq 0.001$.

Total milk consumption decreased 0.03 cup equivalents for every NHANES cycle from 2001-2018. Flavored milk consumption did not change ($p < 0.05$) from 2001-2018 ($\beta = -0.002$-cup equivalents for every cycle). Overall, there was 54 kJ decrease/cycle. Other changes over time were decreases in intakes of added sugars ($\beta = -0.43$ tsp/cycle), vitamins D ($\beta = -0.08$ µg/cycle), and B-12 ($\beta = -0.05$ µg/cycle), riboflavin ($\beta = -0.02$ mg/cycle) and potassium ($\beta = -11$ mg/cycle); yet, there was an increase in fiber intake ($\beta = 0.11$ g/cycle) (all significant at ($p < 0.0001$)).

Mean Intakes of Selected Nutrients (Table 2)

Variables	Flavored Milk Consumption						β[3]	P value[4]
	Total (N = 28,259, 100%)		Non-consumers (N = 23,510, 83.2%)		Consumers (N = 4,749, 16.8%)			
	Mean	SE	Mean	SE	Mean	SE		
Fiber (g)	13.41	0.09	13.16	0.10	14.51	0.14	1.35	<0.0001
Vitamin D (µg)	5.67	0.06	5.18	0.06	7.82	0.10	2.64	<0.0001
Vitamin A (RE)	587	5.46	562	5.65	696	10.95	133	<0.0001
Vitamin B-12 (mcg)	4.87	0.04	4.77	0.05	5.31	0.07	0.54	<0.0001
Riboflavin (mg)	2.02	0.01	1.95	0.01	2.32	0.02	0.37	<0.0001
Calcium (mg)	1009	7.32	961	7.71	1220	11.71	259	<0.0001

Magnesium (mg)	232	1.24	227	1.35	252	2.04	25	<0.0001
Potassium (mg)	2188	13.12	2124	13.99	2469	23.42	345	<0.0001
Phosphorus (mg)	1255	6.98	1215	7.05	1432	12.79	218	<0.0001

Table 2: Nutrient intake by flavored milk consumption for children 2 to 18 years: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[2]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[3]Is the regression coefficient of difference between non-consumers and consumers.

[4]Significance was defined as $p \leq 0.001$.

Flavored milk consumers 2-to-18 years, had significantly ($p < 0.0001$) higher intakes of fiber, vitamins D, A and B-12, riboflavin, calcium, potassium, magnesium and phosphorus than non-consumers. Mean nutrient intakes of selected nutrients among flavored milk consumers compared to non-consumers by specific age groups are presented in supplemental tables 7 to 11.

Variables	Flavored Milk Consumption						Beta[3]	P value[4]
	Total (N: 4,770)		Non-consumers (N: 4,630, 96.8%)		Consumers (N: 170, 3.2%)			
	Mean	SE	Mean	SE	Mean	SE		
Total milk (C eq)	1.40	0.04	1.36	0.04	2.67	0.18	1.31	<0.0001
Flavored milk (C eq)	0.04	0.01	0.00	0.00	1.35	0.13	1.35	<0.0001
Total energy (Kcal)	1092	11.21	1077	11.20	1531	52.08	454	<0.0001
Added sugars (tsp eq)	4.58	0.14	4.33	0.13	12.22	0.75	7.89	<0.0001
Fiber (g)	6.48	0.11	6.39	0.12	9.22	0.50	2.82	<0.0001
Vitamin D (µg)	8.82	0.09	8.78	0.09	9.99	0.51	1.21	0.0207
Vitamin A (RE)	603	6.75	603	6.78	584	31.39	-19.67	0.5305
Vitamin B-12 (mcg)	3.40	0.05	3.36	0.05	4.68	0.25	1.32	<0.0001
Riboflavin (mg)	1.62	0.02	1.60	0.02	2.14	0.08	0.54	<0.0001
Calcium (mg)	892	11.13	881	11.30	1219	54.86	338	<0.0001
Magnesium (mg)	145	1.63	143	1.66	199	6.03	55.85	<0.0001
Potassium (mg)	1587	17.42	1567	17.63	2169	76.11	601	<0.0001
Phosphorus (mg)	807	10.49	794	10.59	1182	45.51	388	<0.0001

Supplemental Table 7: Nutrient intake by flavored milk consumption for children < 2 years: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Beta is the regression coefficient of difference between non0consumers and consumers.

[4]Significance was defined as p≤0.001.

Variables	Flavored Milk Consumption						Beta[3]	P value[4]
	Total (N: 3,864)		Non-consumers (N: 3,309, 84.5%)		Consumers (N: 555, 15.5%)			
	Mean	SE	Mean	SE	Mean	SE		
Total milk (C eq)	1.67	0.03	1.56	0.03	2.30	0.07	0.74	<0.0001
Flavored milk (C eq)	0.21	0.02	0.00	0.00	1.36	0.06	1.36	<0.0001
Total energy (Kcal)	1470	10.56	1436	11.14	1652	32.62	215	<0.0001
Added sugars (tsp eq)	11.06	0.18	10.19	0.18	15.75	0.46	5.56	<0.0001
Fiber (g)	10.72	0.14	10.59	0.15	11.41	0.30	0.83	0.0150
Vitamin D (µg)	6.57	0.10	6.27	0.11	8.19	0.22	1.91	<0.0001
Vitamin A (RE)	547	7.71	532	8.26	625	18.61	93	<0.0001
Vitamin B-12 (mcg)	4.23	0.06	4.15	0.07	4.66	0.13	0.51	0.0004
Riboflavin (mg)	1.79	0.02	1.74	0.02	2.07	0.04	0.33	<0.0001
Calcium (mg)	968	12.53	934	13.57	1149	25.19	215	<0.0001
Magnesium (mg)	194	1.76	190	2.01	220	4.13	30.69	<0.0001
Potassium (mg)	2001	18.02	1950	19.80	2276	45.92	326	<0.0001
Phosphorus (mg)	1065	9.97	1034	11.16	1234	23.54	200	<0.0001

Supplemental Table 8: Nutrient intake by flavored milk consumption for children 2 to 3 years: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Beta is the regression coefficient of difference between non0consumers and consumers.

[4]Significance was defined as $p \leq 0.001$.

Variables	Flavored Milk Consumption						Beta[3]	P value[4]
	Total (N: 7,762)		Non-consumers (N: 5,845, 72.5%)		Consumers (N: 1,917, 27.5%)			
	Mean	SE	Mean	SE	Mean	SE		
Total milk (C eq)	1.45	0.02	1.21	0.02	2.08	0.04	0.86	<0.0001
Flavored milk (C eq)	0.33	0.01	0.00	0.00	1.20	0.03	1.20	<0.0001
Total energy (Kcal)	1791	9.84	1740	10.35	1924	20.62	184	<0.0001
Added sugars (tsp eq)	16.89	0.19	15.99	0.21	19.25	0.35	3.27	<0.0001
Fiber (g)	12.70	0.10	12.29	0.12	13.77	0.19	1.47	<0.0001
Vitamin D (µg)	5.92	0.07	5.22	0.07	7.76	0.13	2.54	<0.0001
Vitamin A (RE)	590	7.17	555	7.66	681	13.99	126	<0.0001
Vitamin B-12 (mcg)	4.57	0.05	4.37	0.06	5.07	0.08	0.70	<0.0001

Riboflavin (mg)	1.95	0.02	1.83	0.02	2.27	0.03	0.43	<0.0001
Calcium (mg)	968	12.53	934	13.57	1149	25.19	215	<0.0001
Magnesium (mg)	215	1.39	207	1.56	237	2.58	29.31	<0.0001
Potassium (mg)	2081	16.13	1977	16.09	2357	31.78	380	<0.0001
Phosphorus (mg)	1177	8.06	1110	8.67	1352	17.36	242	<0.0001

Supplemental Table 9: Nutrient intake by flavored milk consumption for children 4 to 8 years: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Beta is the regression coefficient of difference between non0consumers and consumers.

[4]Significance was defined as $p \leq 0.001$.

Variables	Flavored Milk Consumption						Beta[3]	P value[4]
	Total (N: 8,117)		Non-consumers (N: 6,578, 79.7%)		Consumers (N: 1,539, 20.3%)			
	Mean	SE	Mean	SE	Mean	SE		
Total milk (C eq)	1.31	0.03	1.14	0.03	2.00	0.05	0.87	<0.0001
Flavored milk (C eq)	0.24	0.01	0.00	0.00	1.16	0.03	1.16	<0.0001
Total energy (Kcal)	2025	14.05	1987	15.70	2172	26.97	184	<0.0001
Added sugars (tsp eq)	20.17	0.25	19.95	0.28	21.04	0.53	1.08	0.0743
Fiber (g)	14.30	0.16	13.95	0.17	15.69	0.26	1.74	<0.0001
Vitamin D (µg)	5.58	0.10	5.08	0.11	7.55	0.18	2.47	<0.0001
Vitamin A (RE)	614	10.49	586	10.91	722	20.04	136	<0.0001
Vitamin B-12 (mcg)	4.96	0.08	4.80	0.09	5.57	0.14	0.77	<0.0001
Riboflavin (mg)	2.07	0.02	1.99	0.02	2.38	0.04	0.39	<0.0001
Calcium (mg)	1024	13.13	964	14.24	1257	20.41	292	<0.0001
Magnesium (mg)	238	2.18	231	2.47	263	3.57	31.25	<0.0001
Potassium (mg)	2208	20.54	2120	22.37	2551	40.52	430	<0.0001
Phosphorus (mg)	1293	11.98	1239	12.79	1502	19.98	263	<0.0001

Supplemental Table 10: Nutrient intake by flavored milk consumption for children 9 to 13 years: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Beta is the regression coefficient of difference between non0consumers and consumers.

[4]Significance was defined as $p \leq 0.001$.

Variables	Flavored Milk Consumption						Beta[3]	P value[4]
	Total (N: 8,516)		Non-consumers (N: 7,738, 90.2%)		Consumers (N: 738, 9.8%)			
	Mean	SE	Mean	SE	Mean	SE		
Total milk (C eq)	1.13	0.03	1.02	0.03	2.11	0.08	1.09	<0.0001
Flavored milk (C eq)	0.09	0.01	0.00	0.00	1.13	0.07	1.13	<0.0001
Total energy (Kcal)	2206	17.86	2192	18.22	2330	54.04	137	0.0139
Added sugars (tsp eq)	23.42	0.30	23.37	0.32	23.82	0.86	0.44	0.6231
Fiber (g)	14.28	0.14	14.09	0.15	16.07	0.43	1.98	<0.0001
Vitamin D (µg)	5.16	0.10	4.82	0.10	8.28	0.32	3.46	<0.0001
Vitamin A (RE)	574	8.39	558	8.96	725	28.71	167	<0.0001
Vitamin B-12 (mcg)	5.34	0.08	5.28	0.09	5.84	0.24	0.56	0.0280
Riboflavin (mg)	2.12	0.03	2.08	0.03	2.51	0.07	0.43	<0.0001
Calcium (mg)	1033	12.36	1002	12.50	1314	39.44	312	<0.0001
Magnesium (mg)	255	2.41	252	2.55	289	6.99	37.55	<0.0001
Potassium (mg)	2344	25.01	2302	26.74	2726	65.89	424	<0.0001
Phosphorus (mg)	1367	12.98	1339	13.10	1629	40.88	291	<0.0001

Supplemental Table 11: Nutrient intake by flavored milk consumption for children 14 to 18 years: NHANES* 2001-2018[1-2].

*NHANES: National Health and Nutrition Examination Surveys 2001-2018.

[1]We determined the least square means and standard errors (SE) of energy and intakes of each nutrient. Based on self-reported questionnaire responses, the covariates included age, gender, race/ethnicity, and household poverty income ratio (PIR).

[2]Flavored milk was defined as one of 32 different USDA food codes including all forms of dairy chocolate milk, all forms of dairy milk with added cocoa or chocolate syrup, and all forms of dairy milk with flavors other than chocolate. Flavored soy and other milk replacements products were not included in this study. Flavored milk consumers were defined as those reporting any amount of flavored milk consumed in the day one recall.

[3]Beta is the regression coefficient of difference between non0consumers and consumers.

[4]Significance was defined as $p \leq 0.001$.

Differences between non-consumers and consumers of flavored milk by age, ethnicity, gender and PIR were also examined (data not shown). In general, consumers of flavored milk had significantly higher intakes of fiber, vitamins D, A and B-12, riboflavin, calcium, potassium, magnesium, and phosphorus than non-consumers; regardless of age, ethnicity, gender and PIR.

Percentage meeting dietary recommendations of selected nutrients **(Figures 1 and 2)**

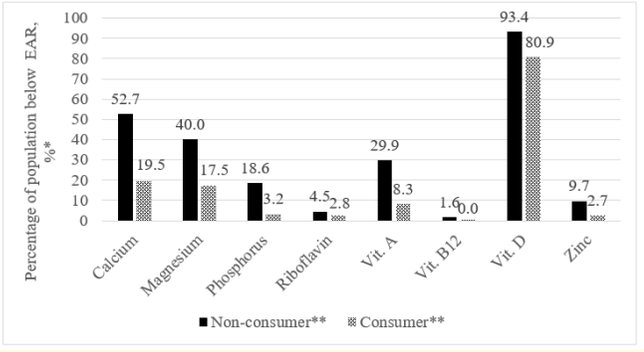

Figure 1: Nutrient adequacy (percentage below Estimated Average Requirements (EAR)) by flavored milk consumption for children 2 to 18 years: National Health and Nutrition Examination Surveys 2001-2018.

*For nutrient adequacy the two dietary recalls and the National Cancer Institute usual intake (UI) programs were used for the estimation of UI. To assess inadequate intake, the Estimated Average Requirements (EAR) cut point method was used. Z-scores were used to assess population differences in nutrient adequacy. Significance was defined as $p \leq 0.001$.

**Differences between consumers and non-consumers significant, $p < 0001$ for all nutrients.

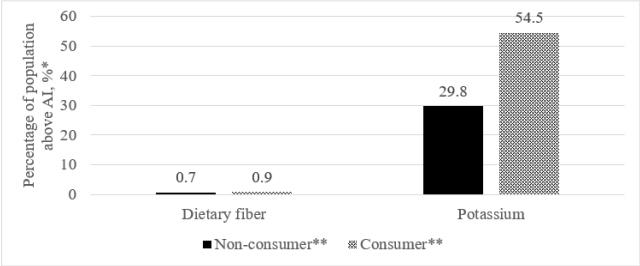

Figure 2: Percentage of population above Adequate Intake (AI) by flavored milk consumption for children 2 to 18 years: National Health and Nutrition Examination Surveys 2001-2018.

*For nutrient adequacy, the two dietary recalls and the National Cancer Institute usual intake (UI) programs were used for the estimation of UI. For nutrients without an Estimated Average Requirement, the percent above Adequate Intake was calculated. Z-scores were used to assess population differences in nutrient adequacy. Significance was defined as $p \leq 0.001$.

**Differences between consumers and non-consumers significant of potassium, $p < 0001$.

Overall, the percentage of children 2-18 years not meeting the dietary recommendations based on Estimated Average Requirement (EAR) was highest for vitamin D (91%),vitamin A (26%), calcium 47%), and magnesium (36%). Compared to non-consumers, consumers of flavored milk had a lower percentage not meeting the EAR for vitamins A ($\beta = -21.6\%$, $P < 0.0001$), and B-12 ($\beta = -1.5$, $p < 0.0001$), riboflavin ($\beta = -1.4$, $p < 0.0001$), calcium ($\beta = -33.3$, $p < 0.0001$), magnesium ($\beta = -33.3$, $p < 0.0001$), and phosphorus ($\beta = -15.4$, $p < 0.0001$). The percentage of flavored milk consumers with intakes above the AI was lower for fiber intake ($p = 0.0001$) but higher for potassium intake ($p < 0.0001$) compared to non-consumers. Overall, <1% of the total sample had fiber intakes above the AI recommendation.

The significant nutritional contribution of dairy products in the diets of children has been well documented [2-10]. Milk appears to be the principal dairy product consumed by children [14]. Furthermore, 68% of all milk available to children in schools in the USA is flavored milk, specifically chocolate milk [19,20]. Despite the nutritional benefits of flavored milk, there is no clear consensus on how flavored milk fits into a healthy eating pattern.

An important contribution of this study beyond other published studies is the variation in the contribution of flavored milk to intakes of nutrients of public health concern compared to the added sugars content using the most recent national dataset. This study was initiated after the 2020 Dietary Guidelines Advisory Committee (DGAC) confirmed that nutrients of public health concern included calcium, potassium, vitamin D and dietary fiber along with other nutrients provided in milk specifically, vitamins A and B-12, magnesium and phosphorus. In addition, it was equally important to re-examine the nutritional contribution of flavored milk compared to the lowering of the added sugars recommendation to < 6% of energy. This would provide further understanding on whether the nutritional benefits of flavored milk outweighs the added sugars content [1].

Data showed that consumers of flavored milk had higher total energy intake, total sugar intake and total added sugars compared to non-consumers. Intakes of added sugars was higher among consumers of flavored milk compared to non-consumers, but, consumers of flavored milk consumed approximately 1-cup equivalent more total milk compared to non-consumers.

The increased milk consumption among consumers of flavored milk may in part explain the significantly higher intakes of vitamins A, D and B-12, riboflavin, calcium, potassium, magnesium and phosphorus than non-consumers. These higher intakes of nutrients among consumers of flavored milk reflect a lower percentage not meeting the EAR recommendations for these nutrients of public health concern.

While mean dietary fiber intakes were significantly higher among flavored milk consumers compared to non-consumers, there was no significant difference in the percentage meeting the AI recommendation for dietary fiber. This was not surprising because the percentage meeting the AI recommendation for dietary fiber was < 1% for both consumers and non-consumers of flavored milk. The mean fiber intakes among flavored milk consumers was only 1.4 g higher than non-consumers. One possible explanation for the small but higher fiber intakes among flavored milk consumers could reflect the small amount of carrageenan, a soluble fiber extract, added to chocolate milk, as a thickener and gelling agent [41].

One can argue that the lower percentages not meeting the current dietary recommendation may not be a meaningful finding with a significant public health impact. However, it is important to put into perspective what these percentages actually represent on a total population basis. For example, although only 20% of flavored milk consumers had calcium intakes below the EAR compared to 53% among non-consumers, these percentages equate to 29.8 million children not meeting the calcium recommendation among non-consumers compared to only 2.5 million children who consumed flavored milk. In this regard, the public health impact could be substantially relevant to helping children meet recommendations for nutrients of public health concern.

Added sugars account for more than 13% of total energy [42]. The major sources of added sugars in the typical U.S diet are sugar-sweetened beverages (24%), desserts and sweet snacks (19%), coffee and tea (11%) and candy (9%) with only 4% of added sugars from milk and yogurt. The current study confirms that added sugars from flavored milk was only 3.8%. It is important to note that there was only one-teaspoon difference in the amount of added sugars consumed among consumers (20.2 tsp) and non-consumers (18.9 tsp).

Additional analyses for this study showed that sugar-sweetened beverages were the number one food source of added sugars for both consumers and non-consumers of flavored milk. Among consumers the second food source of added sugars was flavored milk compared to sweet bakery products among non-consumers of flavored milk. Other than this important difference, the other food/beverage sources of added sugars were similar among consumers and non-consumers of flavored milk. Another highlight relevant to this study was that for flavored milk consumers the number one source of calcium, vitamin D, and potassium and the second source for added sugars and fiber was flavored milk. Thus, the data suggests that consumers of flavored milk while getting added sugars also obtained important nutrients of public health concern compared to non-consumers who also consumed foods with added sugars but with no additional nutritional benefits (data not shown).

The results highlight an important finding on the potential trade-off between the differences in nutrient intakes and the one-teaspoon difference in added sugars intakes between consumers and non-consumers of flavored milk. Compared to non- consumers, consumers of flavored milk had higher intakes of vitamin D by 51%, calcium by 27%, potassium by 16% and fiber by 10%. An important public health message from these findings is that individuals should choose foods low in added sugars that also contribute nutrients that are of public health concern. If foods with added sugars are going to be consumed it is better for these foods to also contribute nutrients as occurs with flavored milk. However, it is equally important to keep in mind when translating research into practice, it is the whole diet that matters not a single food or nutrient.

Limitations

This study had a number of limitations. NHANES is a cross-sectional study, thus cause and effect relationships cannot be determined. Another limitation is the use of dietary recalls to assess intake in NHANES. Participants relied on memory to self-report dietary intakes; therefore, data were subject to non-sampling errors, including under or over-reporting of energy and foods, particularly those foods with added sugars. Parents reported or assisted their children 2-11 years with the 24-hour recalls; parents often report accurately what children eat in the home [43] but may not know what their children consume outside the home [44], which could also result in reporting errors [45]. The results could reflect the influence of other foods consumed/not consumed throughout the day among the added sugars groups [46,47]. Finally, vitamin and mineral supplement data were not included in the analyses. When interpreting the results one needs to consider the methodological limitations in defining added sugars, methods of analytical approaches and the variation in the added sugars content of foods and beverages across nutrient data bases [47-51].

Another limitation is the potential for residual confounding. The results do not directly associate flavored milk consumption alone for the differences shown in nutrient intakes and nutrient adequacy. It may be that other foods consumed among the flavored milk consumers are different from the foods consumed among non-consumers; thus, having an impact on the nutrient profiles of the two-milk consumption groups. It is well recognized that children do not consume foods and/or nutrients in isolation. It is the overall dietary eating pattern that impacts one's nutritional profiles.

Finally, it is important to understand nutritional epidemiology in formulating the role of public policy recommendations, Archer., *et al.* [52] calls into question the validity of data from the NHANES and suggests that "the ability to estimate population trends in caloric intake and generate empirically supported public policy rel-

evant to diet-health relations from US nutritional surveillance is extremely limited." However, NHANES has been repeatedly been used for supporting DGA recommendations over the past decade or so.

Conclusion

Based on data from this observational study, and confirmed by others, flavored milk is not a bad beverage choice. The nutritional benefits of flavored milk far outweighs the added sugars content. One can argue that the new added sugars recommendation is overly restrictive and could potentially have unintended consequences on meeting the total milk consumption requirement, and more importantly, on helping more children to meeting recommendations for nutrients of public health concern.

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Conflict of Interest

T.A.N and R.S. received an honorarium from Nutrition Impact for manuscript development. VLF III as Vice President of Nutrition Impact, LLC conducts NHANES analyses for numerous members of the food, beverage and dietary supplement industry.

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