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Beverage Displacement between Elementary and Middle School, 2004-2007

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ABSTRACT

Background Sweetened beverages of low nutritional quality might be displacing more nutritious beverages, such as 100% fruit juice and milk, from children's diets. However, previous research has not examined changes in beverage intake over time using nationally representative longitudinal data.

Objective Our objective was to examine changes in sweetened beverage, milk, and juice consumption between 5th and 8th grade.

Design We used a longitudinal analysis of self-reported beverage consumption.

Participants/setting Data were from the Early Childhood Longitudinal Survey–Kindergarten Cohort 1998-1999 (ECLS-K), a nationally representative study of children followed from kindergarten through 8th grade. This analysis used data from Spring 2004 and 2007, when most children were in 5th and 8th grade, respectively (n=7,445).

Main outcome measures Main outcome measures were changes in consumption of sweetened beverages, milk, and 100% fruit juice last week.

Statistical analyses performed Survey-adjusted linear regression was used to estimate longitudinal relationships between servings of milk, sweetened beverages, and 100% fruit juice, controlling for child and family characteristics and food consumption.

Results Children's milk consumption decreased between 5th and 8th grade, and these decreases were larger among children who drank sweetened beverages daily. However, after controlling for demographic characteristics, changes in children's milk consumption were not significantly related to changes in their consumption of sweetened beverages over time (β=.005; P=0.81), while changes in milk consumption were positively related to changes in juice consumption (β=.087; P<0.01).

Conclusions Observed decreases in average milk consumption from 5th to 8th grade were not related to changes in sweetened-beverage consumption. They were positively related to changes in fruit juice consumption, so not indicating displacement. Caloric beverages generally tended to increase or decrease in tandem, so focus must be placed on their role in children's entire diet and on balancing them with food and total beverage intake.

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PATTERNS OF BEVERAGE CONSUMPTION AMONG children and adolescents in the United States suggest that sugar-sweetened beverages of low nutritional quality might be replacing more nutritious beverages, such as 100% fruit juice and milk, in children's diets.[1-4] Specifically, national cross-sectional data indicate that milk consumption decreased among children ages 2 to 18 years between 1977 and 2001, and soda consumption more than doubled during that period.[5] The simultaneous timing of these changes suggests that sugar-sweetened beverages might have displaced more nutritious drinks in children's diets.

Understanding whether less nutritious beverages are displacing more nutritious beverages is important because such displacement can have negative long-term health consequences. For example, soda consumption has been associated with lower dietary intake of vitamin A and C, calcium, magnesium, and riboflavin in children and adolescents.[1,6] Increases in soft drinks and fruit juice in children's diet are linked to increases in their total caloric intake, which can lead to weight gain and increased obesity risks.[7-14] Obese children are more likely to become obese adults,[15] increasing their risk of other chronic conditions, including hypertension, type 2 diabetes, and premature cardiovascular disease.[15,16]

Several studies have examined whether sweetened beverages displace milk and 100% fruit juice from children's diets. A study in Louisiana found that 10-year-olds who consumed large quantities of sweetened beverages drank less milk than did those who consumed few or no sweetened beverages.[17] A longitudinal study that examined annual 3-day food and beverage diaries among children in Iowa from age 1 to 5 years found that milk intake was inversely associated with intake of sweetened beverages at almost every age examined.[18] A longitudinal study of 24-hour diet recalls among elementary school children in Nebraska found that during a 2-year period,

sugar-sweetened beverages displaced milk in their diets.[8] Another study found that as students in Minnesota moved from elementary to junior high or middle school, their consumption of milk decreased and their consumption of soft drinks increased.[19]

These studies are suggestive of beverage displacement in children. However, to date, no study has examined beverage displacement using nationally representative longitudinal data. The objective of this study was to examine longitudinal changes in sweetened beverages, milk, and juice consumption between 5th and 8th grade using a large, nationally representative study, the Early Childhood Longitudinal Survey–Kindergarten Cohort 1998-1999 (ECLS-K). Approximately 90% of children aged 2 to 19 years consume sweetened beverages or fruit juice and at least 70% consume milk, making these beverages the most common caloric beverages consumed by school-aged children.[20]

MATERIALS AND METHODS

Data Source

The data for this study are from the ECLS-K, which followed a nationally representative cohort of almost 20,000 children in the United States from kindergarten to 8th grade. The ECLS-K was developed by the National Center for Education Statistics of the US Department of Education.[21] Multistage probability sampling was used to select a nationally representative sample of children who were in kindergarten in 1998-1999 or in first grade in 1999-2000. The primary sampling units were counties and groups of counties, with a second-stage selection of schools within the sampled primary sampling units and a third-stage unit of students within schools.

The ECLS-K included interviews with parents, teachers, and school administrators and direct anthropometric assessments of the children. In the 5th and 8th grade, children filled out a food-consumption questionnaire that had 19 questions about food and beverages developed by the US Department of Agriculture based on the Youth Risk Behavior Surveillance System and California Children's Eating and Exercise Practices Survey. Evidence of validity of these questions has been previously published.[22]

This study used data from the 6th and 7th waves of data collection, administered in Spring 2004 and 2007, when most children were in 5th and 8th grade, respectively. Most sample attrition from the cohort resulted from random selection for nonsampling due to survey costs, maintaining the nationally representative nature of the data.[23] We used data on all 7,445 children with complete data (no missing responses to beverage consumption questions, age, sex or race/ethnicity) in both the 5th and 8th grade. This study was conducted using publicly available data and was determined to be exempt by Emory University's Institutional Review Board.

Measures

Children were asked the following questions about their drink consumption over the past 7 days:

1. How many times did you drink soda pop (examples, Coke, Pepsi, Mountain Dew), sport drinks (example, Gatorade), or fruit drinks that are not 100% fruit juice (examples, Kool-Aid, Hi-C, Fruitopia, Fruitworks)?
2. How many glasses of milk did you drink? (Include all types of milk, including cow's milk, soy milk, or any other kind of milk; include the milk you drank in a glass or cup, from a carton, or with cereal. Count the half pint of milk served at school as equal to one glass.)
3. How many times did you drink 100% fruit juices such as orange juice, apple juice, or grape juice? (Do not count punch, Kool-Aid, sport drinks, or other fruit-flavored drinks).

For the sweetened beverage and juice questions, children chose one of the following: none, 1 to 3 times during the last week, 4 to 6 times during the last week, 1 time per day, 2 times per day, 3 times per day, or 4 or more times per day. For the milk question, children chose one of the following: 1 to 3 glasses during the last week, 4 to 6 glasses during the last week, 1 glass per day, 2 glasses per day, 3 glasses per day, or 4 or more glasses per day. Based on the responses to these questions, we created three measures of children's consumption of each type of beverage: whether they reported consuming any, whether they reported consuming it at least daily, and the number of servings they reported consuming during the last week. We calculated servings last week by using the mean value for categories (eg, 1 to 3 times per week was coded as 2 servings per week). For children who reported daily consumption, we multiplied frequencies or servings per day (1 through 4) by 7.

Control Variables

The regression models controlled for parent-reported child characteristics that might be related to beverage intake. These characteristics included sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, Asian or Pacific Islander, American Indian, and multiracial, with non-Hispanic white as the omitted category), and socioeconomic status. Socioeconomic status was based on an ECLS-K–created variable reflecting parental income, education, and occupational prestige, based on parent reports; indicator variables for four of five quintiles were used. Preliminary analyses indicated associations between sweetened-beverage consumption and public vs private school attendance, whether the child eats school lunch regularly, eats school breakfast regularly, or receives free or reduced price lunch at school. These variables, therefore, were also included. Because food intake is related to beverage intake, the other nutrition indicators collected in the ECLS-K were also included, they are: changes in consumption of salad, potatoes, carrots, other vegetables, fruit, and fast food, as reported by children. Additional models were stratified by sex, race/ethnicity, or poverty status to determine whether displacement occurred in specific demographic subgroups. The household poverty variable was created by the National Center for Education Statistics by comparing income with Census poverty thresholds, with households whose income fell below the threshold classified as living in poverty. The results reported here were robust to including other potentially relevant characteristics: number of days per week the child is active for at least 20 minutes, the number of hours of television watched per week, body mass index, and family characteristics (whether the mother works full time, whether other children live in the household, the number of days the family eats dinner together per week, and

Table 1. Demographic characteristics and consumption of milk and 100% fruit juice by frequency of sweetened-beverage consumption during the previous week, among US children in 5th and 8th grade[a]

	All		None		Any		Daily	
	5th Grade	8th Grade	5th Grade	8th Grade	5th Grade	8th Grade	5th Grade	8th Grade
n	7,445	7,445	1,159	1,177	6,286	6,268	2,113	1,912
Child characteristics	%							
Female	49.9	49.9	53.5	56.1	49.2	48.7	46.6	44.6
White, non-Hispanic	58.4	58.4	50.5	53.2	59.9	59.4	57.6	56.7
Black, non-Hispanic	16.5	16.5	21.1	18.7	15.6	16.1	18.2	19.6
Hispanic	18.0	18.0	18.0	17.5	18.0	18.0	18.9	19.1
Asian/Pacific Islander, non-Hispanic	3.8	3.8	5.4	6.5	3.4	3.2	2.5	1.9[b]
American Indian, non-Hispanic	1.3	1.3	1.7	1.6	1.3	1.3	1.4	1.6
Multiracial	2.0	2.0	3.2	2.4	1.8	2.0	1.5	1.2
Attends public school	87.7	88.7[b]	85.7	87.9	88.0	88.8	90.7	90.6
Eats school lunch regularly	78.5	77.0	78.7	71.7[b]	78.5	78.0	81.6	80.0
Eats school breakfast regularly	29.8	26.6[c]	29.0	27.9	29.9	26.4[c]	34.4	31.6
Living in poverty[d]	20.4	19.5	22.4	21.7	20.0	19.1	23.5	21.4
Receives free/reduced price school lunch	37.9	33.9[c]	42.1	34.8[b]	37.1	33.8[c]	42.8	38.0[b]
Family socioeconomic status[e]								
Bottom quintile	18.9	19.5	21.8	20.6	18.3	19.2	21.3	22.3
Second quintile	18.5	20.6[c]	17.0	17.2	18.8	21.2[c]	25.2	24.1
Third quintile	19.4	20.1	20.7	18.4	19.1	20.4	18.6	22.5 [b]
Fourth quintile	20.6	18.8[b]	19.7	18.8	20.8	18.8[b]	18.7	17.7
Top quintile	22.7	21.1[c]	20.9	24.9	23.0	20.3[c]	16.1	13.5
Food consumption	*frequency per week*							
Green salad	2.2	2.6[c]	2.8	2.8	2.1	2.6[c]	2.2	3.0[c]
Potatoes (not fries or chips)	2.0	2.1	1.7	2.1	2.1	2.1	2.8	2.7
Carrots	2.8	1.9[c]	3.5	2.0[c]	2.7	1.9[c]	3.1	2.0[c]
Other vegetables	5.2	4.9[b]	5.6	5.5	5.1	4.8[b]	6.3	5.6[b]
Fruit	7.7	7.2[b]	8.1	8.0	7.6	7.1[b]	9.4	8.3[b]
Fast food	3.2	2.4[c]	2.6	1.5[c]	3.3	2.6[c]	4.9	3.7[c]
Total servings of caloric beverages last week	21.6	19.7[c]	15.1	14.4	22.8	20.6[c]	33.2	29.9[c]
Sweetened beverages	%							
Drank sweetened beverages at all	83.7	84.1	0	0	100	100	100	100
Drank sweetened beverages daily	29.0	27.0	0	0	34.6	32.1	100	100
	no. of servings							
Sweetened beverages last week	6.2	5.5[c]	0	0	7.4	6.5[c]	15.8	14.3[c]
	%							
Share of reported caloric beverage consumption	29.1	28.9	0	0	34.8	34.4	51.7	52.5
Milk								
Drank milk at all	88.7	86.5[c]	83.5	84.0	89.7	87.0[c]	87.0	84.0
Drank milk daily	53.5	46.3[c]	51.4	46.7	53.9	46.2[c]	58.9	49.4[c]
	no. of servings							
Milk last week	10.3	8.5[c]	9.7	8.5[b]	10.4	8.5[c]	10.9	8.7[c]
	%							
Share of reported caloric beverage consumption	46.3	42.1[c]	58.6	56.4	43.9	39.4[c]	30.7	27.3[c]

(continued on next page)

Table 1. Demographic characteristics and consumption of milk and 100% fruit juice by frequency of sweetened-beverage consumption during the previous week, among US children in 5th and 8th grade[a] *(continued)*

	All		None		Any		Daily	
	5th Grade	8th Grade	5th Grade	8th Grade	5th Grade	8th Grade	5th Grade	8th Grade
Juice	← % →							
Drank 100% fruit juice at all	75.0	82.3[c]	72.0	76.2	75.6	83.4[c]	75.1	81.6[c]
Drank 100% fruit juice daily	24.8	27.9[c]	28.6	31.9	24.0	27.1[b]	33.6	37.2
	← *no. of servings* →							
Servings of 100% fruit juice last week	5.1	5.6[c]	5.5	5.9	5.1	5.6[b]	6.5	6.9
	← % →							
Share of reported caloric beverage consumption[f]	23.5	28.1[c]	34.9	38.2	21.3	26.2[c]	17.6	20.2[c]

[a]Data are from the Early Childhood Longitudinal Survey–Kindergarten Cohort 1998-1999, with children observed in the 6th and 7th wave of data collection (2003 and 2006). Survey-adjusted sample means are shown.
[b]Indicates that 5th and 8th grade means are different at the 0.05 level using *t* tests.
[c]Indicates that 5th and 8th grade means are different at the 0.01 level using *t* tests.
[d]Living in poverty indicates that the family is below the Federal poverty threshold.
[e]Socioeconomic quintile is based on parental income, education, and occupational prestige.
[f]Shares of reported caloric beverage consumption are calculated as servings of each beverage type as a percentage of total servings of caloric beverages last week.

the number of days the family eats breakfast together per week).

Statistical Methods

T tests were used to test differences in demographic characteristics. Ordinary least squares regressions with longitudinal data were used to estimate the relationship between changes in children's consumption of milk, sweetened beverages, and 100% fruit juice during the previous week. The results indicate how changes in consumption were related, controlling for other characteristics. $P<0.05$ indicated significance.

The dummy variable adjustment method was used for the small number of observations with missing data on control variables. This method involves creating for each variable with missing values a dummy variable equal to 1 if an individual had a missing value for that variable and setting the variable itself equal to a constant.[24] Observations were weighted using the child-parent weights for the 6th and 7th survey wave panel, which account for attrition and nonresponse. The empirical methods corrected for the complex sample design of the ECLS-K using the svy command in Stata 11.

RESULTS

Table 1 reports sample means for demographic characteristics and measures of beverage intake by children's frequency of sweetened-beverage consumption (none, any, and daily) during the previous week for each grade. Children who drank sweetened beverages at all or daily were more often male and white. In addition, children who drank sweetened beverages daily more often attended public school, ate school lunch regularly, ate school breakfast regularly, and received free/reduced price school lunch.

Overall, children's reported caloric drink servings per week fell considerably between 5th and 8th grade from 21.6 to 19.7 servings. Milk consumption fell between 5th and 8th grade (both absolutely and as a share of reported caloric beverage consumption), and consumption of 100% fruit juice increased, regardless of sweetened-beverage consumption. Milk consumption fell more, both absolutely and as a proportion of initial servings, among children who drank any sweetened beverages than among children who drank none. The decline in milk consumption was even larger among children who drank sweetened beverages daily; that group drank an average of two fewer glasses of milk in 8th grade than in 5th grade.

Table 2 presents regression estimates of how the change in milk consumption is related to the changes in sweetened-beverage and juice consumption, controlling for child demographic and nutrition characteristics. The change in children's consumption of milk between 5th and 8th grade was not related to the change in their consumption of sweetened beverages ($\beta=.005$; $P=0.81$). The change in juice consumption was also not related to the change in children's consumption of sweetened beverages ($\beta=.039$; $P=0.08$). This pattern indicates that sweetened beverages did not displace other caloric beverages from children's diets. Changes in milk consumption and juice consumption were positively related; children who increased their milk consumption also increased their juice consumption during the 3-year period. This pattern indicates that milk and juice are complements, not substitutes, in children's diets.

Table 2 also shows results stratified by population subgroups. We did not find evidence of displacement between caloric beverages among children regardless of their sex, race, or poverty status. Among boys and girls, whites, and Hispanics, and regardless of poverty status, the change in children's milk consumption was positively related to the change in their juice consumption but not to the change in their sweetened-beverage consumption. Among both boys and children in poverty, changes in juice consumption were positively related to changes in sweetened-beverage consumption, indicating that the two were complements. Changes in milk consumption were not significantly related to changes in either juice or sweetened-beverage consumption for blacks or

Table 2. Survey-adjusted linear regression estimates of the association between changes in milk consumption or juice consumption and changes in servings of other caloric beverages between 5th and 8th grade among US children[a]

	All[b]	Girls	Boys	Whites	Blacks	Hispanics	Asians	Living in poverty[c]	Not living in poverty
n	7,445	3,757	3,688	4,872	640	1,169	456	1,112	6,333
Outcome: servings of milk									
Servings of sweetened beverages	0.005	−0.033	0.033	0.014	−0.025	0.004	0.025	0.026	−0.008
	(0.019)	(0.031)	(0.026)	(0.025)	(0.056)	(0.042)	(0.119)	(0.040)	(0.023)
Servings of 100% fruit juice	0.087**	0.077**	0.091**	0.081**	0.050	0.151**	0.097	0.123*	0.074**
	(0.022)	(0.029)	(0.030)	(0.029)	(0.054)	(0.043)	(0.071)	(0.042)	(0.026)
Outcome: servings of juice									
Servings of sweetened beverages	0.039	0.015	0.060*	0.010	0.073	0.051	0.138	0.119*	0.008
	(0.022)	(0.031)	(0.030)	(0.026)	(0.050)	(0.038)	(0.075)	(0.056)	(0.023)
Servings of milk	0.066**	0.061*	0.067**	0.050**	0.056	0.132**	0.080	0.120**	0.051**
	(0.017)	(0.024)	(0.021)	(0.019)	(0.053)	(0.038)	(0.057)	(0.042)	(0.019)

[a]Data are from the Early Childhood Longitudinal Survey-Kindergarten Cohort 1998-1999. Values are coefficient estimates from linear regression models, with standard errors in parentheses. Models include sex and race/ethnicity, family socioeconomic status, public/private school attendance, whether the child eats school lunch regularly, eats school breakfast regularly, receives free or reduced-price lunch at school, and the change in consumption of salad, potatoes, carrots, other vegetables, fruit, and fast food, as reported by children.
[b]Results shown for all children and stratified by sex, race/ethnicity, and poverty status.
[c]Living in poverty indicates that the family is below the Federal poverty threshold.
*$P<0.05$.
**$P<0.01$.

Asians. Analyses of multiple subpopulations of children indicate that milk and juice consumption increased or decreased in tandem for most children. Changes in sweetened-beverage consumption were not inversely related to changes in milk or juice consumption among any subgroup.

DISCUSSION

This is the first study to examine displacement of caloric drinks over time in a large, nationally representative study of children. Changes in children's milk and juice consumption during a 3-year period were not negatively related to changes in their consumption of sweetened beverages. The observed decreases in average milk consumption from 5th to 8th grade were not associated with increases in sweetened-beverage consumption. Regardless of sweetened-beverage consumption, milk and 100% fruit juice were complements in children's diets, with children who increased their consumption of one also increasing their consumption of the other. Among boys and among children living in poverty, juice and sweetened-beverage consumption were complements, with children increasing or decreasing their consumption of the two drinks in tandem.

Previous longitudinal studies showed that increases in sweetened-beverage consumption accompanied decreases in milk and fruit juice intake from early childhood into adolescence.[18,25,26] For example, one study showed that girls who consumed soda at age 5 had higher soda intake, lower milk intake, higher intake of added sugars, and lower nutrient intake from age 5 to 15 years compared with girls who did not consume soda at age 5.[27] Another study using a small, regional sample concluded that consumption of juice and milk declined and consumption of soft drinks increased between 3rd and 8th grade.[19] However, these studies lacked generalizability due to small sample sizes, focus on a specific geographic location, or restriction of the sample to specific racial/ethnic groups. It is possible that the difference between those results and the results here are due to cohort differences: this study used more recent data (2004-2007) than previous work, and displacement might have occurred among earlier cohorts of children but not among children born in 1992-1993.

The results indicate that relationships between changes in the consumption of sweetened beverages, milk, and juice between 5th and 8th grade were generally similar across sex, racial, ethnic, and socioeconomic groups. Specifically, milk and juice were complements for all groups, and sweetened beverages were not substitutes for milk or juice in any groups. Juice and sweetened beverages were complements for boys and for children living in poverty. Previous studies documented differences in food, beverage, and activity patterns among children by sex[28] and ethnic groups.[11,20,27] However, although some of these studies were longitudinal or based on nationally representative data, none of the studies were both.

In addition to finding that changes in milk consumption between 5th and 8th grade were not related to changes in consumption of sweetened beverages, we also found that there was no significant change in patterns of children with any or daily sweetened-beverage consumption as opposed to no sweetened-beverage consumption. This might be because children's sweetened-beverage consumption patterns are already established by 5th grade. Still, it might not indicate that consumption of these beverages did indeed stay constant, as the ECLS-K asked only about the number of times of sweetened beverage were consumed, not about the size of those portions without increases in frequency of consumption.

This study faces several limitations. Like most national sur-

veys, the ECLS-K did not include a measure of water intake,[5,20] so we were not able to determine whether the observed decreases in the total consumption of caloric beverages reflected an increase in water consumption or simply a decrease in beverage intake. However, as sweetened beverages, milk, and juice have been shown to be the dominant beverage consumed by children aged 2 to 19 years,[20,29] our finding that children reduced the frequency of their intake of caloric beverages likely indicates that they reduced their liquid calories. Still, the dietary data were based on a retrospective food questionnaire, not a food diary, so we cannot estimate how children's total caloric intake changed with changes in their beverage consumption. However, as all caloric beverages contribute to overall caloric intake, it is concerning that these main caloric beverages consumed by children—milk, juice, and sweetened beverages—were complementary to each other.

Previous work indicates that the accuracy of children's dietary reporting increase with repeated administration of the same food questionnaire with at least 25 days between questionnaires.[30] Therefore, reports in the ECLS-K may have been more accurate at the second administration, in 8th grade, particularly since the children were 3 years older. However, the ECLS-K asks about frequency of consumption, not serving sizes, which might not provide the same information. Although this limitation can introduce noise into our estimates, it does not imply a bias in the results.

Finally, children might have not understood what beverages they were being asked about and might not have known, for example, which juice drinks were 100% juice. Children were not specifically asked to exclude diet drinks from their reports, so it is possible that some children included diet drinks in their reports of sugar-sweetened-beverage consumption, even though the examples did not include diet drinks. However, it has been shown that <8% of children ages 2 to 19 years consume diet beverages.[20]

The study offers several strengths. The data are from a large, nationally representative longitudinal dataset. The longitudinal nature of the data allows us to examine changes among the same children over time. This controls for much of the unobserved heterogeneity that can confound cross-sectional analyses. The ECLS-K is the only study of this scale to have collected information on beverages from children of elementary and middle school ages. It also has sufficient sample sizes to examine nationally representative subsets of children by sex, race and ethnicity, and poverty status.

CONCLUSIONS

Reducing the intake of caloric beverages is a priority, given the high prevalence of overweight and obesity. This focus is especially important because the results presented here indicate that caloric beverages tend to be complementary with each other—as children increase their intake of one caloric beverage they also increase their intake of the others. Caloric beverages must be seen within the context of the entire diet and must be balanced with food intake. It is important for dietetics practitioners to help children and their families understand that caloric beverages, even those that are generally healthy, contribute to children's total energy intake and must be moderated as part of a healthy diet.

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