The Association of Sugar-Sweetened Beverage Intake During Infancy With Sugar-Sweetened Beverage Intake at 6 Years of Age

abstract

OBJECTIVES: To examine whether sugar-sweetened beverage (SSB) intake during infancy predicts SSB intake at 6 years of age.

METHODS: A longitudinal cohort analysis of 1333 US children was conducted by using data from the 2005–2007 Infant Feeding Practices Study II and the 2012 Follow-Up Study at 6 years of age. The exposure variables were maternal-reported SSB intakes during infancy. The outcome variable was maternal-reported SSB intake at age 6 years. Multivariable logistic regression analyses were used to calculate adjusted odds ratios (aOR) for associations of SSB intake during infancy with consuming SSBs ≥1 time/day at 6 years old after controlling for baseline child's and parent's characteristics.

RESULTS: Based on maternal recall, approximately one-fifth of children consumed SSBs at least 1 time/day at age 6 years. Adjusted odds of consuming SSBs at age 6 years ≥1 time/day was significantly associated with any SSB intake during infancy (aOR, 2.22 vs none), age at SSB introduction (aOR, 2.33 for age ≥6 months and 2.01 for age <6 months vs never), and mean SSB intake during age 10 to 12 months (aOR, 2.72 for 1 to <2 times/week and 2.57 for ≥3 times/week vs none).

CONCLUSIONS: SSB intake during infancy significantly increased the likelihood of consuming SSBs ≥1 time/day at 6 years of age. Our findings suggest that infancy may be an important time for mothers to establish healthy beverage practices for their children and these findings can be used to inform intervention efforts to reduce SSB intake among children. *Pediatrics* 2014;134:S56–S62

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KEY WORDS

sugar-sweetened beverage, children, Infant Feeding Practice Study II

ABBREVIATIONS

aOR—adjusted odds ratios
CI—confidence interval
IFPS II—Infant Feeding Practices Study II
OR—odds ratios
SSB—sugar-sweetened beverage
Y6FU—Year 6 Follow-Up

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Sugar-sweetened beverages (SSBs) are the largest source of added sugars, which are significant contributors of calories in the diets of US children.[1] Furthermore, the consumption of SSBs has been associated with obesity,[2–4] dental caries,[5] asthma,[6] displacement of nutrient-rich foods,[7,8] and poor academic grades[9] in youth. Based on the 2010 Dietary Guidelines for Americans, SSBs are defined as "liquids that are sweetened with various forms of sugars that add calories. These beverages include, but are not limited to, soda, fruit ades and fruit drinks, and sports and energy drinks."[10] Based on the 2008 Feeding Infants and Toddlers Study, 10.7% of infants aged 9 to 11.9 months and 14.3% of children aged 12 to 14.9 months consumed SSBs on a given day (ie, carbonated sodas, fruit-flavored drinks, sports drinks, sweetened tea and coffee, and other) in the United States.[11] According to the National Health and Nutrition Examination Survey data in 2007–2008, 66% of US children aged 2 to 11 years consumed any SSBs on any given day.[12] Several family-related and environmental factors have been associated with SSB intake among youth, including permissive parenting practices,[13] parental SSB intake,[14,15] and access to SSB in the home and schools.[15–18]

An innate taste preference for sweet taste and repeated exposure to sweetened beverages and foods may enhance the desire for it and thus increase preference for and consumption of sweet-tasting beverages and foods.[19] An experimental study among children aged 6 to 10 years reported that exposure to sugar water during infancy was associated with the intensity of sucrose preferred during childhood, and those who were habitually fed sugar water during infancy preferred significantly higher levels of sucrose concentration when compared with children who were seldom fed sugar water.[20] However, to our knowledge, no previous study has examined the association between the consumption of SSBs during infancy and intake of SSBs in childhood using prospective longitudinal data. Thus, the purpose of our study was to examine whether intake of SSBs during infancy predicts the consumption of SSBs at age 6 years.

METHODS

Study Population and Survey Administration

The Infant Feeding Practices Study II (IFPS II), conducted by the Food and Drug Administration and Centers for Disease Control and Prevention in 2005–2007, is a national longitudinal study that followed the mothers of infants from late pregnancy throughout the first year of life. IFPS II was conducted among a sample of pregnant mothers from a consumer opinion mail panel of about half a million households. A series of 11 questionnaires were mailed to pregnant mothers during the last trimester of pregnancy and at approximately months 1, 2, 3, 4, 5, 6, 7, 9, 10, and 12 after birth. Detailed information on this survey administration and data collection have been previously published.[21]

A total of 1542 children who participated in both IFPS II and a Year 6 Follow-Up (Y6FU) survey in 2012 were included. About half (48%) of the children who participated in the original survey were lost to follow-up at 6 years of age.[22] For this analysis, we excluded 16 children because they were >13 months old when they participated in the last survey of IFPS II, 6 children who had missing data on the outcome variable (SSB intake at 6 years of age), and 158 children who did not have any original SSB data (ie, had no SSB intake information) in 1 to 6 months' or 7 to 12 months' surveys, resulting in a final analytic sample of 1333 children. The IFPS II and Y6FU studies were approved by the Food and Drug Administration Institutional Review Board. Our secondary analysis using de-identified data were deemed exempt by the CDC Institutional Review Board.

Outcome Variable

The main outcome measure was daily SSB intake at 6 years of age. Parents were asked "During the past month, how often did your 6-year-old drink regular soda or pop that contains sugar? Don't include diet soda or diet pop," and "During the past month, how often did your 6-year-old drink sweetened drinks: Kool-Aid, lemonade, sweet tea, Hi-C, cranberry cocktail, Gatorade, etc?" For each question, parents reported no consumption or the number of times per day, per week, or per month their child consumed these beverages. Weekly or monthly intake was converted to daily intake. The frequency of intake of regular soda and other SSBs was summed to calculate total SSB intake frequency. Three mutually exclusive SSB intake categories were created (0, >0 to <1, or ≥1 time/day) for χ^2 tests, and 2 categories were created for logistic regression analysis (<1 and ≥1 time/day).

Exposure Variables

The exposure variables were obtained from a series of 10 postpartum surveys throughout infancy (~3 weeks and 2, 3, 4, 5, 6, 7, 9, 10, and 12 months of age) on intake of SSBs. In each approximately monthly survey of IFPS II, parents were asked "In the past 7 days, how often was your baby fed sweet drinks: juice drinks, soft drinks, soda, sweet tea, Kool-Aid, etc?" Parents reported number of times per day or per week their infant was fed the item or wrote 0 when their baby was not fed these beverages. Some mothers did not complete the survey questionnaire within several days or weeks of receiving it, so their reported infant's ages were inconsistent with the

survey month. Therefore, we analyzed the SSB data according to the age of infants when the questionnaire was completed. Because there was a large proportion of missing values for the exposure variables (ranges, ~1%–27% during infancy), we imputed values for these exposure variables and covariates based on their non-missing values and other relevant non-missing values. Of note, covariates had rather small percentages of missing data (ranges, 0%–4.6%). Detailed information on this multiple imputation methodology is available in Pan et al's study published as part of this *Pediatrics* supplement.[23] The Amelia II package in R was used to perform 25 imputations.[24,25] Because of the longitudinal nature of the surveys during infancy, with SSB intakes assessed 10 times during infancy, we treated these surveys as a time series for each child.

For SSB intake during infancy, we estimated any SSB intake during infancy (no or yes), age at SSB introduction during infancy (never, ≥6 months, or <6 months), and mean SSB intake during 10 to 12 months (no SSB, <1, 1 to <3, or ≥3 times/week). To define a late infancy, we used 10 to 12 months. Any SSB intake during infancy was categorized as "yes" if the mother reported any consumption of SSBs during the 1-, 2-, 3-, 4-, 5-, 6-, 7-, 9-, 10-, and 12-month surveys, and categorized as "no" if no SSB intake was reported in all of these surveys. We estimated the age at introduction to SSBs by calculating the midpoint between the age of the infant when SSBs were first reported and the age of the infant on the previous questionnaire in which the mother did not indicate that her infant was receiving any SSBs. Then, we created a categorical variable using 6 months as a cutoff for age at SSB introduction during infancy. For mean SSB intake during 10 to 12 months, we calculated an average of the SSB intake at 10 and at 12 months.

Covariates

Covariates included child and maternal characteristics obtained from the baseline study (IFPS II). Child covariates included gender, birth weight (≤4000 or >4000 g), and breastfeeding duration (<6 or ≥6 months). Maternal sociodemographic variables included age (18–24, 25–29, 30–34, or ≥35 years), pre-pregnancy weight status (underweight and normal weight, BMI <25 kg/m^2; overweight, BMI 25 to <30 kg/m^2; and obese, BMI ≥30 kg/m^2) based on self-reported weight and height data collected during the last trimester, as well as maternal race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), education (≤high school, some college, or college graduate), marital status (married or not married), income-to-poverty level (<185, 185–349, or ≥350%), and parity (primiparous or multiparous) collected during prenatal period. For marital status, not married included widowed, divorced, separated, and never married.

Statistical Analysis

χ^2 tests were used to examine the unadjusted bivariate relationship between frequency of SSB intake and child and parental characteristics, and $P < .05$ was the cutoff for statistical significance. Logistic regression analyses were used to estimate crude odds ratio and 95% CI for examining the associations of SSB intake at age 6 years and SSB intake during infancy. Any SSB intake during infancy, age at SSB introduction, and mean SSB intake during 10 to 12 months of age were modeled separately. For adjusted models, odds ratios were adjusted for all covariates described previously. Additionally, we conducted multivariable logistic regression analysis for age at introduction during infancy among children who were fed SSBs during infancy and mean SSB intake during 10 to 12 months of age among children who were fed SSBs during 10 to 12 months of age. All statistical analyses were performed by using SAS callable SUDAAN software version 9.3 (SAS Institute, Cary, NC) and accounted for multiple imputation.

RESULTS

Respondents' characteristics at baseline and the prevalence of SSB intake in the past month at age 6 years by child and maternal characteristics are shown in Table 1. Only 19.4% of children aged 6 years did not consume SSBs, 62.0% consumed SSBs >0 to <1 time/day, and 18.6% consumed SSBs ≥1 time/day during the past month. Baseline characteristics significantly associated with SSB intake at age 6 years were breastfeeding duration, maternal education, marital status, income-to-poverty level, and pre-pregnancy weight status ($P <$ .05 based on χ^2 tests). Specifically, the proportion of 6-year-old children consuming SSBs ≥1 time/day was the highest among children who were breastfed <6 months and among children whose mother was less educated, not married, lower income, or obese before this pregnancy.

Overall, 27.0% of infants were fed SSBs during infancy, 8.8% of infants were fed SSB before 6 months of age, and 6.7% of infants consumed SSBs ≥3 times/week during 10 to 12 months of age. Furthermore, SSB intake at age 6 years varied by the consumption of SSBs during infancy ($P <$ .05 for all χ^2 tests). The proportion of 6-year-old children consuming SSBs ≥1 time/day was the highest among children who were fed any SSBs during infancy, those who were fed SSBs at or after 6 months and before 6 months of age, and those who consumed SSB ≥3 times/week at 10 to 12 months of age (Table 2).

Based on logistic regression analyses, the crude odds of consuming SSBs ≥1 time/day at 6 years of age was greater among children who consumed any

TABLE 1 Respondents' Characteristics at Baseline and the Prevalence of SSB Intake in the Past Month at 6 y of Age by Characteristics, IFPS II, 2005–2007 and Y6FU Study, 2012

Characteristic at baseline	All, *n* (%)[b]	SSB[a] Intake During the Past Month at Age 6 y			
		0 Times/d, %[b]	>0 to <1 Time/d, %[b]	≥1 Time/d, %[b]	*P* Value[c]
Total	1333 (100)	19.4	62.0	18.6	
Child's gender					.98
Boy	668 (50.1)	19.2	62.1	18.7	
Girl	665 (49.9)	19.6	61.9	18.5	
Child's birth weight					.85
≤4000 g	1160 (87.0)	19.7	61.7	18.6	
>4000 g	173 (13.0)	17.9	63.6	18.5	
Breastfeeding duration					<.0001
<6 mo	657 (49.3)	17.0	58.4	24.6	
≥6 mo	676 (50.7)	21.8	65.5	12.8	
Maternal age					.20
18–24 y	188 (14.1)	14.4	61.8	23.9	
25–29 y	428 (32.1)	20.1	61.3	18.7	
30–34 y	429 (32.2)	18.6	64.1	17.2	
≥35 y	287 (21.5)	23.0	60.0	17.1	
Maternal race/ethnicity					.79
White, non-Hispanic	1166 (87.5)	19.5	62.0	18.5	
Black, non-Hispanic	46 (3.5)	17.7	61.5	20.8	
Hispanic	67 (5.0)	17.0	59.2	23.8	
Other, non-Hispanic	54 (4.1)	22.7	65.2	12.2	
Maternal education					<.0001
≤High school	231 (17.3)	14.3	57.5	28.2	
Some college	466 (35.0)	20.0	57.7	22.4	
College graduate	636 (47.7)	20.9	66.8	12.3	
Marital status					.03
Not married	209 (15.7)	20.2	54.4	25.4	
Married	1124 (84.3)	19.3	63.4	17.3	
Income-to-poverty level					.001
<185%	456 (34.2)	16.9	58.8	24.3	
185% to 349%	502 (37.7)	18.5	64.5	16.9	
≥350%	375 (28.1)	23.7	62.4	13.9	
Pre-pregnancy weight status					.01
Underweight or normal weight (<25.0 kg/m^2)	648 (48.7)	23.0	60.3	16.7	
Overweight (25 to <30 kg/m^2)	343 (25.7)	14.7	65.7	19.6	
Obese (≥30 kg/m^2)	341 (25.6)	17.4	61.5	21.2	
Parity					0.06
Primiparous	391 (29.3)	22.9	57.2	19.9	
Multiparous	942 (70.7)	18.0	64.0	18.1	

[a] SSBs at age 6 y include regular soda, sweetened drinks such as Kool-Aid, lemonade, sweet tea, Hi-C, cranberry cocktail, Gatorade, and others.

[b] Sample distribution, percentages may not add up to 100% because of rounding.

[c] χ^2 test was used for each variable to examine differences across categories; $P < .05$.

SSBs during infancy (odds ratios [OR], 2.61; 95% confidence interval [CI], 1.91–3.57 vs never fed SSBs during infancy), those who were fed SSB at or after 6 months (OR, 2.61; 95% CI, 1.84–3.71 vs never) or before 6 months (OR, 2.61; 95% CI, 1.62–4.23 vs never), and those who had a mean consumption of SSBs 1 to <3 times/week during 10 to 12 months of age (OR, 3.04; 95% CI, 1.78–5.17 vs no SSBs) or ≥3 times/week during 10 to 12 months of age (OR, 3.05; 95% CI, 1.90–4.92 vs no SSBs) (Table 3).

Based on the multivariable logistic regression analyses, after controlling for all covariates included in our study the likelihood of consuming SSBs ≥1 time/day at 6 years of age was greater among children who were fed any SSBs during infancy (aOR, 2.22; 95% CI, 1.59–3.10 vs never fed SSBs during infancy), those who were fed SSB at or after age 6 months (aOR, 2.33; 95% CI, 1.61–3.38 vs never) or before age 6 months (aOR, 2.01; 95% CI, 1.23–3.30 vs never), and those who had a mean consumption of SSBs 1 to <3 times/week during 10 to 12 months of age (aOR, 2.72; 95% CI, 1.57–4.72 vs no SSBs) or ≥3 times/week during 10 to 12 months of age (aOR, 2.57; 95% CI, 1.56–4.23 vs no SSBs during 10 to 12 months) (Table 3). When we limited the analysis among SSB consumers only, odds of consuming SSB ≥1 time/day at age 6 years did not significantly differ between children who were fed SSBs before 6 months of age and those who consumed SSB at or after 6 months of age (aOR, 0.84; 95% CI, 0.48–1.46; data not shown). In addition, odds of consuming SSB ≥1 time/day at age 6 years did not differ by mean SSB intake during 10 to 12 months of age among SSB consumers only (aOR, 1.62; 95% CI, 0.6–4.37 for 1 to <3 times/week and aOR, 1.54; 95% CI, 0.60–3.91 for ≥3 times/week vs <1 time/week; data not shown).

DISCUSSION

Our findings indicated that 81% of children in this study population consumed SSBs at 6 years of age based on maternal recall of child's intake in the past 30 days. Based on the 2007–2008 National Health and Nutrition Examination Survey data, 66% of US children aged 2 to 11 years consumed any SSBs on any given day using a 24-hour dietary recall.[12] Our study also observed variability in intake with 10% differences among categories of household income and maternal education. Moreover, our findings showed that any consumption of SSBs during infancy was predictive of SSB intake at 6 years of age. For example, compared with children who were never fed SSBs, children who were fed SSBs at any time during infancy had 2.22 times higher

TABLE 2 Associations Between SSB Intake During Infancy and SSB Intake at 6 y of Age, IFPS II, 2005–2007 and Y6FU Study, 2012 (n = 1333)

SSB Intake During Infancy[b]	All, n (%)[c]	SSB[a] Intake During the Past Month at 6 y of Age			
		0 Times/d, %[c]	>0 to <1 Time/d, %[c]	≥1 Time/d, %[c]	P Value[d]
Any SSB intake during infancy					<.0001
No SSBs	973 (73.0)	22.0	63.8	14.3	
Any SSBs	360 (27.0)	12.6	57.1	30.3	
Age at SSB introduction during infancy					
Never consumed SSBs during infancy	973 (73.0)	22.0	63.8	14.3	
SSB introduction at or after age 6 mo	242 (18.2)	10.7	59.0	30.3	<.0001
SSB introduction before age 6 mo	118 (8.8)	16.6	53.1	30.3	
Mean SSB intake during 10 to 12 mo of age					<.0001
No SSBs	1095 (82.2)	21.8	62.7	15.5	
<1 time/wk	62 (4.7)	9.0	66.0	25.1	
1 to <3 times/wk	86 (6.5)	8.1	56.2	35.8	
≥3 times/wk	89 (6.7)	8.3	55.8	35.9	

[a] SSBs at age 6 y include regular soda, sweetened drinks such as Kool-Aid, lemonade, sweet tea, Hi-C, cranberry cocktail, Gatorade, and others.
[b] SSBs during infancy includes juice drinks, soft drinks, soda, sweet tea, Kool-Aid, and others.
[c] Sample distribution, percentages may not add up to 100% because of rounding.
[c] χ^2 test was used for each variable to examine differences across categories, $P < .05$.

odds for consuming SSBs at least once per day at 6 years of age after controlling for all potential covariates included in this study.

Additionally, although age ranges of samples are different from our study, 1 prospective study reported that soda (ie, carbonated SSB or artificially sweetened beverages, caffeinated or decaffeinated) drinkers at age 5 years continued to have higher mean consumption of sodas from age 7 years to age 15 years among 166 girls,[26] which may suggest that SSB intake during early childhood might influence SSB intake in later childhood and continue through adolescence.

Timing of SSB introduction during infancy did not play a significant role in terms of increasing risk for SSB intake at age 6 years among SSB consumers. Regardless of age of SSB introduction during infancy (ie, before age 6 months or at or after age 6 months), if children were fed SSBs anytime during infancy, it increased the odds for daily consumption of SSBs at age 6 years approximately twofold compared with children who never consumed SSBs during infancy. However, frequency of mean SSB intake during 10 to 12 months of age may have a role in increasing odds for SSB intake at age 6 years, because the odds for daily consumption of SSBs at age 6 years increased with greater mean SSB intake during 10 to 12 months of age.

TABLE 3 The Associations of SSB Intake During Infancy With SSB Intake ≥1 Time/d at 6 y of Age, IFPS II, 2005–2007 and Y6FU Study, 2012 (n = 1333)

SSB Intake During Infancy[b]	SSB Intake ≥1 Time/d at 6 y of Age[a]	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)[c]
Any SSB intake during infancy		
No SSBs	Reference	Reference
Any SSBs	2.61[d] (1.91–3.57)	2.22[d] (1.59–3.10)
Age at SSB introduction during infancy		
Never consumed SSBs during infancy	Reference	Reference
SSB introduction at or after 6 mo	2.61[d] (1.84–3.71)	2.33[d] (1.61–3.38)
SSB introduction before 6 mo	2.61[d] (1.62–4.23)	2.01[d] (1.23–3.30)
Mean SSB intake during 10 to 12 mo of age		
No SSBs	Reference	Reference
<1 time/wk	1.81 (0.89–3.68)	1.68 (0.79–3.61)
1 to <3 times/wk	3.04[d] (1.78–5.17)	2.72[d] (1.57–4.72)
≥3 times/wk	3.05[d] (1.90–4.92)	2.57[d] (1.56–4.23)

[a] SSBs at age 6 y include regular soda, sweetened drinks such as Kool-Aid, lemonade, sweet tea, Hi-C, cranberry cocktail, Gatorade, and others. Reference group was SSB intake <1 time/d.
[b] SSBs during infancy include juice drinks, soft drinks, soda, sweet tea, Kool-Aid, and others.
[c] Models adjusted for child's gender, child's birth weight, breastfeeding duration, maternal age, maternal race/ethnicity, maternal education, marital status, income-to-poverty ratio, pre-pregnancy BMI, and parity.
[d] Significant findings are based on the 95% CI (ie, the CI does not include 1).

A previous study reported that early exposure to sugar water was significantly associated with the intensity of sucrose preferred during childhood, and children who were repeatedly fed sugar water during infancy had significantly higher levels of sucrose preference when compared with those who were rarely fed sugar water at this age.[20] Because early feeding practices can modify taste preference and may have long-term effects on food preferences, including the preference for sweet-tasting foods and beverages,[19,27] as well as parents who might be consistently feeding similar beverages to their children throughout infancy and childhood, it may be important to establish healthy dietary habits in early life by avoiding the feeding of SSBs during infancy. Including this recommendation as part of parenting skills education programs potentially may influence the reduction of SSB consumption among infants and children, as mothers who fed more SSBs to infants may also be more likely to provide SSBs to their children as they grow up.

Our study has at least 2 strengths. First, IFPS II is the largest longitudinal study of infant feeding practices in the United States. Second, the comprehensive survey questionnaire permitted us to adjust for a wide range of potential confounding factors. However, our results are subject to limitations. First,

the findings are not generalizable nationally, because the mothers included in the IFPS II were a convenience sample from a consumer opinion mail panel survey, with a majority of mothers in the study being non-Hispanic whites who had more than a high school education. Previous studies have shown that SSB intake prevalence was higher among black children than among white children and higher among those who live with parents who have a lower level of education than those who live with parents who have a higher level of education.[12,16] Thus, it is reasonable to assume that SSB consumption may be an even more critical issue in certain subgroups than observed in our study. Second, SSB consumption was surveyed in terms of frequency, so that we cannot quantify the relationship by the volume of SSB consumption. Third, the validity of the survey instruments has not been tested. Lastly, missing data were imputed. Although multiple imputation methodology was used to estimate missing values on exposure variables (ie, SSB consumption during infancy) and covariates to decrease the potential biases affected by missing data, the residual bias remains unknown.

CONCLUSIONS

Almost 1 in 5 children aged 6 years in our sample consumed SSBs at least once daily. Any consumption of SSBs during infancy was a significant predictor for consuming SSBs at least 1 time per day among 6-year-old children. However, among SSB consumers only, timing of SSB introduction during infancy or dose was not significantly associated with SSB intake at 6 years of age. Our findings suggest that infancy may be an important time for mothers to establish healthy beverage practices for their children and these findings can be used to inform intervention efforts to reduce SSB intake and potential adverse consequences among children.

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