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Nutrition Education

Associations between Child and Parent Knowledge of Added Sugar Recommendations and Added Sugar Intake in Multiethnic Elementary-Aged Children

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ABSTRACT

Background: A key goal of the Dietary Guidelines for Americans 2015–2020 is to reduce added sugar intake by increasing public knowledge about added sugars. However, research has not shown if knowledge of added sugar recommendations is associated with intake.

Objectives: To determine the relation between parent and child knowledge of added sugar recommendations with added sugar intake in primarily low-income and Hispanic third- to fifth-grade students.

Methods: Analysis examined baseline, cross-sectional data from TX Sprouts, a 1-y cooking, gardening, and nutrition clustered randomized controlled trial. Participants were 685 parent-child dyads from 16 elementary schools in the greater Austin area. Parents and children completed a survey to assess knowledge of added sugar recommendations. Children completed two 24-h dietary recalls to assess average intake of added sugars. Mixed effects linear regression models were used to estimate associations between child and parent knowledge of added sugar recommendations and average total added sugar intake.

Results: Children who correctly identified the added sugar recommendation consumed lower amounts of added sugar compared with children who did not correctly identify the recommendation (34.8 ± 2.7 compared with 41.0 ± 2.5 g; $P = 0.003$), after adjusting for sociodemographic characteristics. Parent knowledge of added sugar recommendations was not associated with child intake.

Conclusions: Child knowledge of added sugar recommendations was associated with lower intake of added sugars. Findings suggest that child nutrition education should focus on increasing knowledge of national recommendations. Future research should investigate a causal relation between added sugar knowledge and intake in elementary-aged children. *Curr Dev Nutr* 2020;4:nzaa140.

Keywords: added sugars, diet, nutrition knowledge, dietary recommendations, elementary-age children

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Introduction

The average 4–13-y-old child in the United States consumes >150% of the recommended amount of added sugar per day, a behavior that increases the child's risk of developing adverse and chronic health conditions later in life (1, 2). Added sugars are defined as any sugar, syrup, or concentrate added to a food or beverage during processing or preparation (3, 4). Studies consistently show a link between added sugar intake and unfavorable BMI (5). Added sugar intake, specifically that from sugar-sweetened beverages, is highly associated with increased adiposity in children (6, 7). Added sugar intake is also associated with type 2 diabetes in adults and insulin resistance in adolescents who are overweight or obese (8, 9).

Due to the adverse health effects of added sugar consumption, the Dietary Guidelines for Americans (DGA) has encouraged reduction of added sugars since its first publication in 1980 (10). The 2015–2020 DGA was the first to publicize a quantifiable recommendation for added sugar alone, recommending that <10% of daily calories come from added sugars (11). Although nutritional needs vary by sex and age, consumer nutrition education materials typically use a 2000-calorie diet for reference. For a 2000-calorie diet, 10% of calories is equivalent to ~50 g, or ~12 teaspoons, of added sugars (12, 13).

Despite these recommendations, the US diet continues to have an excess of added sugars, with an average 13.4% of daily calories from added sugars for individuals aged >1 y (1, 14). Added sugar intake varies by race and ethnicity (12). In children, added sugar intake does not vary

by household income (12). Approximately 67% of children aged 2–19 y in the United States consume diets that exceed the added sugar recommendation (12). The diets of children aged 9–13 y and 14–18 y are the highest in added sugars across all age groups, averaging 17% of calories from added sugars (2, 11).

A key goal of the dietary guidelines is to reduce added sugar intake by increasing public knowledge about added sugars (11). Previous research has shown that adult use of MyPlate or MyPyramid is associated with diets that are lower in calories, sodium, added sugar, and cholesterol, as well as higher in whole grains and vegetables (15). Even without these tools, simple nutritional knowledge is associated with healthier diets in adults (16, 17). Research on associations between parent knowledge and child dietary intake appears to be inconclusive (18–20), although parent nutrition knowledge has been shown to predict child knowledge (21). Younger children can be more influenced by their parents' dietary knowledge than older children (19, 22). In children, nutrition knowledge has been shown to be associated with higher vegetable intake (22). Yet, despite education being a key goal of the DGA, to our knowledge, no research has been conducted to study if knowledge of the recommendations for added sugar is associated with decreased added sugar intake in children.

The aim of this study was to determine the relation between parent and child knowledge of added sugar recommendations and added sugar intake in children aged 7–12 y. It was hypothesized that increased parent and child knowledge of recommendations would be associated with decreased child added sugar intake. Findings of this study could inform efforts to educate the public about added sugars and thus have potential public health implications.

Methods

Description of study

This analysis used cross-sectional, baseline data from TX Sprouts, a cluster randomized controlled trial that examined the effects of a 1-y school-based gardening, cooking, and nutrition program on child obesity, dietary behaviors, and metabolic outcomes. The study targeted third- to fifth-grade students and their families from 16 elementary schools in the Austin area. Baseline data collection occurred between August 2016 and October 2018. Schools included in the study had to meet the following inclusion criteria: *1*) high proportion of Hispanic children (>50%); *2*) high proportion of children participating in the free and reduced lunch program (>50%); *3*) location within 97 km (60 miles) of The University of Texas at Austin; and *4*) no existing garden or gardening program. Full methods of the TX Sprouts intervention are published elsewhere (23). The trial is registered at clinicaltrials.gov (NCT02668744).

Recruitment

All third- to fifth-grade students and parents at the recruited schools were contacted to participate via tables at "Back to School" and "Meet the Teacher" evening events, flyers sent home with students, and teachers making class announcements. Written informed consent was obtained from all parents, and assent from each student was obtained. Both consent and assent were required for inclusion in the study. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Institutional Review Boards of The University of Texas at Austin and the individual school district review boards.

Data collection

At baseline, students completed a 12-page questionnaire during the school day at their respective schools as part of a larger data collection effort for TX Sprouts. Questionnaires included items on demographics (24), food and meal choice behaviors (25), fruit and vegetable preferences (26), beverage intake (27), cooking and gardening attitudes and self-efficacy (28, 29), and nutrition knowledge assessment (28). Questionnaires were provided in both English and Spanish, and bilingual interpreters were available to assist students if needed.

At baseline, parents completed a 12-page questionnaire. Questionnaires were completed either at "Back to School" or "Meet the Teacher" evening events or were sent home with students, completed by a parent, and returned to school with the student. Questionnaires included items on demographics (24), food and meal choice behaviors (30), fruit and vegetable preferences (26), cooking and gardening attitudes and self-efficacy (28, 29), and nutrition knowledge assessment (28). Questionnaires were provided in both English and Spanish. Parents received a $15 gift card to a local grocery store as an incentive for completing the questionnaire.

Nutrition knowledge assessment

This analysis only examined items measuring parent and child knowledge of nutritional recommendations for added sugars. Children and parents were asked "How much added sugar should we eat daily?" and presented with 5 answer choices: <50 g, <75 g, <100 g, 100–200 g, or "I don't know." The correct answer choice was <50 g. All other answer choices were considered incorrect. Although the 2015–2020 DGA recommends that <10% daily calories come from added sugars (11), this study asked about knowledge of added sugar recommendations in grams for several reasons. First, children in third- to fifth-grade might not have learned or gained mastery of the mathematical concept of percentages. Secondly, the updated Nutrition Facts label on food and beverage products provides the amount of added sugar in grams (3). The label also provides the percentage daily value for added sugar within a product and is based on a 2000-calorie daily diet. Additionally this study used grams to align with public health nutrition education materials for consumers, which widely use 50 g added sugar (based on a standard 2000-calorie daily diet) for dietary recommendations.

Twenty-four-hour dietary recalls

All participants completed two 24-h dietary recalls, which were used to calculate average added sugar intake. Both recalls occurred at unannounced times within a 1-wk timeframe. Recalls were collected via telephone by trained staff and supervised by a registered dietitian using Nutrition Data System for Research, a computer-based software application [University of Minnesota Nutrition Coordinating Center (NCC)] that facilitates the collection and analysis of dietary recalls in a standardized fashion (31). Dietary intake data gathered by interview were governed by a multiple-pass interview approach (32). Five distinct passes provided multiple opportunities for the participant to recall food intake. Students took ~20–30 min to complete each recall. A Food Amounts Booklet was distributed to students and used

to estimate serving sizes during recalls. Menus and portion sizes were obtained from school food services to aid in collecting recall data. Parents and/or guardians of students were allowed to assist with recalls as needed. Assistance included recalling food items consumed, cooking methods and preparation, and estimated serving sizes. Students received a $10 incentive for completing both recalls. Quality assurance was performed on all dietary recall data by additional trained research staff.

Statistical analyses

Descriptive statistics (mean, SD, number, percentage of sample) were used to describe the sample and dietary intake. χ^2 tests were used to examine the association between child and parent knowledge of added sugar recommendations. Mixed effects linear regression models were used to estimate associations between child and parent knowledge of added sugar recommendations and average total added sugar intake, with random effects at the school level to account for clustering by schools. All models were adjusted for child age, sex, and ethnicity/race, and for parent ethnicity/race, sex, and education. Robust SEs were calculated to account for heteroscedasticity. All data were analyzed using SPSS Statistics for Macintosh, version 24.0 (IBM Corp.).

Results

Study sample

Of the 4239 eligible students at the 16 elementary schools, 3303 (78%) children consented to be in the TX Sprouts study. Of those consented children, 3137 (94%) completed baseline clinical measures and were in the clinical trial. Two 24-h dietary recalls were collected from a randomly selected subsample of 738 (24%) children in the clinical trial. Of those with dietary recall data, 712 (96%) children also had parent questionnaire data. Cases were then excluded if data were missing for independent variables (child and parent knowledge). The final analytic sample included 685 child-parent dyads.

The parent sample was predominantly female (88%) and Hispanic (59%). Other races comprising the sample were non-Hispanic white (26%), non-Hispanic black (11%), and other (3%). The child sample was 55% female, and ages of children ranged from 7 to 12 y with a mean age of 9.3 ± 0.9 y. **Table 1** provides further detail on the sample demographics. Children consumed an average of 38.4 ± 25.9 g added sugar per day, or 10.3 ± 5.8% of total daily calories. Daily servings of foods and beverages ranked in order by percentage of added sugar to daily total added sugar are presented in **Table 2**. Sugar-sweetened beverages were the largest contributor of added sugar to the diet. On average children consumed 0.48 ± 0.72 servings (~ 4 fluid oz; 118mL) per day.

Knowledge of added sugar recommendations

Child and parent responses to the nutrition knowledge assessment question pertaining to added sugar recommendations are presented in **Table 3**. The majority of parents and children were unable to identify the added sugar recommendation correctly: 53% and 60.9%, respectively (**Table 4**). There was a nonsignificant relation between parent and child knowledge of added sugar recommendations ($\chi^2 = 0.85$; $P = 0.20$) (Table 4). There was also a nonsignificant relation between child and parent knowledge when stratified by whether the child exceeded the <10% of total kilocalorie added sugar recommendations (Table 4).

TABLE 1 Demographics of child and parent sample ($n = 685$)

	n (%) or mean ± SD
Parent demographics	
Sex	
Female	600 (87.6)
Male	77 (11.2)
Missing	8 (1.2)
Ethnicity/race	
Hispanic or Latino	403 (58.8)
Non-Hispanic white	181 (26.4)
Non-Hispanic black	73 (10.7)
Other	17 (2.5)
Missing	11 (1.6)
Educational attainment	
No high school	102 (14.9)
Some high school	61 (8.9)
High-school graduate/General Educational	151 (22.0)
Development	
Some college or vocational school	192 (28.0)
College graduate	132 (19.3)
Graduate or professional training	40 (5.8)
Missing	7 (1.0)
Child demographics	
Sex	
Female	374 (54.6)
Male	311 (45.4)
Age, y	9.3 ± 0.9
Ethnicity/race	
Hispanic or Latino	398 (58.1)
Non-Hispanic white	146 (21.3)
Non-Hispanic black	84 (12.3)
Other	41 (6.0)
Missing	16 (2.3)
Child dietary intake[1]	
Total energy, kcal	1465 ± 531
Added sugar, %/total kcal	10.3 ± 5.8
Added sugar, g/d	38.4 ± 25.9

[1] Intake is averaged from two 24-h dietary recalls.

Main outcomes

After adjusting for sociodemographic characteristics (child age, sex, and ethnicity/race, and parent ethnicity/race, sex, and education), children who were able to identify the added sugar recommendation consumed significantly less added sugar than children who were not able to identify the recommendation (34.8 ± 2.7 compared with 41.0 ± 2.5 g; $P = 0.003$) (**Table 5**). Parent knowledge of the recommendations was not associated with their child's intake of added sugars ($P = 0.12$). No parent or child demographic characteristics were significantly associated with a child's average added sugar intake.

Discussion

Added sugar intake is associated with increased BMI and insulin resistance in children and adolescents (6–9). Due to the adverse health

TABLE 2 Average daily servings of foods and beverage groupings ranked by average contribution of added sugar to the diet in children

Food grouping[1]	Daily servings[2,3] (mean ± SD)	Range of servings[2,3]
Sugar-sweetened beverages (i.e., soda, fruit drinks, tea, water)[4]	0.48 ± 0.72	0–6.00
Ready-to-eat cereals (presweetened)	0.51 ± 0.72	0–4.83
Cake, cookies, pie, pastry, Danish, donut, and cobbler	0.30 ± 0.52	0–4.66
Non-chocolate candy	0.07 ± 0.32	0–4.33
Chocolate candy	0.01 ± 0.09	0–1.50
Frozen dairy and nondairy desserts	0.14 ± 0.38	0–3.00
Sweetened flavored milk	0.24 ± 0.44	0–2.50
Sweetened yogurt[4]	0.03 ± 0.13	0–1.50
Snack bar	0.08 ± 0.24	0–2.55
Syrup, honey, jam, jelly, preserves	0.92 ± 0.27	0–3.00
Sweet sauces, frosting, and glaze	0.01 ± 0.09	0–1.25

[1]Ranked in order by percentage of added sugar by foods within the food grouping to daily total added sugar.
[2]Serving sizes have been assigned to each Nutrition Data System for Research (NDS-R) food and beverage based on the recommendations made by the 2000 Dietary Guidelines for Americans. For foods not included in recommendations (e.g., cookies, fruit drinks), FDA serving sizes have been used.
[3]Servings are based on average across two 24-h dietary recalls.
[4]Does not include artificially sweetened versions.

effects of added sugar consumption, the 2015 DGA recommends that <10% of daily calories come from added sugars (11). Within this sample of low-income, primarily Hispanic elementary-aged children, more than half of students consumed >10% of daily calories from added sugars. Average servings of foods and beverages with high added sugar content were <1 serving. However, high added sugar intake resulted as children consumed foods and beverages from multiple food groups within their daily diets. The upper ranges for several items (sugar-sweetened beverages, ready-to-eat cereals, and non-chocolate candy) were high. A student consuming the upper range of sugar-sweetened beverages (6 servings, 48 fluid oz, or 1.4 liters) would be consuming 156 g added sugar from that 1 source. More than half of children and parents did not know the recommendation provided by the DGA for added sugars. Child knowledge of added sugar recommendations was significantly associated with lower added sugar intake. Parent knowledge of recommendations, however, was not associated with child added sugar intake.

Previous studies support the finding that child nutrition knowledge is associated with dietary intake (15–17, 22, 33). To date, no studies have examined the association between knowledge of added sugar recommendations and added sugar intake in children. However, other studies have examined child nutrition knowledge and intake of dietary components other than added sugars (22, 33). A study of 8–12-y-old, primarily Hispanic children showed that children who received a nutrition education intervention had higher nutrition knowledge, increased self-efficacy to choose healthy foods, and higher consumption of fruits, vegetables, and 100% fruit juice than those who did not participate in the intervention (33). Another study examining primary school children (6–12 y of age) in Japan found that general nutrition knowledge was associated with increased vegetable intake (22). These findings support the idea that child nutrition knowledge can influence dietary intake (22). It appears that the individual consuming the food plays the most influential role in food choice, so it makes sense that child knowledge, over parent knowledge, was found to be significantly related to child intake.

Parent nutrition knowledge is considered to be a predictor of child nutrition knowledge (21), so it was hypothesized that, if child added sugar knowledge was associated with added sugar intake, parent knowledge would also be associated with child intake. However, the results of this analysis did not show an association between parent added sugar knowledge and child added sugar intake. Although this finding was unexpected, it is not surprising. First, parent knowledge did not predict child knowledge in our sample, so the primary reasoning for our hypothesis did not hold true. Second, the influence of parent nutrition knowledge on child dietary intake appears to decrease as children grow older, a trend that is a possible explanation for the results

TABLE 3 Child and parent responses to nutrition knowledge assessment

Question and response categories	Child		Parent	
How much sugar should we eat daily?	Frequency	%	Frequency	%
<50 g	267	39.0	319	46.6
<75 g	105	15.3	45	6.6
<100 g	64	9.3	25	3.6
100–200 g	16	2.3	12	1.7
I don't know	233	34.0	284	41.5

TABLE 4 Child compared with parent knowledge of added sugar recommendations stratified if the child met added sugar recommendations in dietary intake

			Parent identification of added sugar recommendation				
			Correct	Incorrect	Total	χ^2	*P* value
Met <10% total kilocalorie added sugar recommendation	Child identification of added sugar recommendation	Correct	90	68	158		
		Incorrect	95	112	207		
		Total	185	180	365	4.16	0.03
Did not meet <10% total kilocalorie added sugar recommendation	Child identification of added sugar recommendation	Correct	41	69	110		
		Incorrect	93	117	210		
		Total	134	186	320	1.46	0.14
Total	Child identification of added sugar recommendation	Correct	130	137	267		
		Incorrect	188	229	417		
		Total	319	366	685	0.85	0.20

found by this analysis (19, 22). In elementary school, children begin to consume more meals at school, where parents have no control over meal composition (34). Additionally, just as the scientific literature shows that food advertising influences children's food choices (35), nutrition education might influence preferences affecting children's product purchase requests, and these requests might influence parents' purchasing decisions. Finally, previous studies on parent nutrition knowledge and child dietary intake have shown mixed results. Some studies examining parent nutrition knowledge found significant associations with decreased sugar-sweetened beverages (20) and cholesterol (19) intake as well as increased vegetable (20, 22) and fiber intake (19) in children. Other studies failed to show a significant relation between parent nutrition knowledge and child dietary intake (19, 20, 36). A study examining mothers who used daycares found that maternal nutrition knowledge was not associated with child consumption of high-sugar foods (36). Additional studies failed to show an association between parent knowledge and sweet consumption (20) and micronutrient intake (19, 20) in children.

This analysis used a sample of primarily low-income and Hispanic individuals. The Hispanic population is one of the fastest growing ethnic minority groups in the United States (37). Hispanic populations in the United States have a higher prevalence of obesity, type 2 diabetes, and cardiovascular disease risk factors than non-Hispanic white populations (38). Similarly, low-income populations are at higher risk of obesity, type 2 diabetes, and cardiovascular disease than higher income populations (39–41). Considering the association of added sugars with these disease risks, the study of added sugar knowledge and intake in these populations has important implications for disease prevention. Another strength of this study was the use of multipass 24-h dietary recalls to measure child intake of added sugars. This approach is regarded as the gold standard of self-reported dietary data collection (42). Therefore, the added sugar measurements used in this study are considered to be accurate.

The use of cross-sectional data in this study prevents exploration of causality and restricts the analysis only to draw associations between variables. Changes in nutrition knowledge and added sugar intake will be examined in the future using intervention data from TX Sprouts. The 24-h dietary recalls used in this study to obtain child intake of added sugars are subject to bias, measurement error, and influences of social desirability (42, 43). Dietary assessment in children poses other challenges including potential limitations in their concept of time, recognition of foods and preparation methods, ability to estimate portion sizes, motivation, literacy, concentration, and memory (44–46). However, when measurement error is taken into consideration during data analysis and interpretation, self-reported intake remains valuable (42, 47). An additional limitation of this analysis is the exclusion of a variety of variables known to affect behavior. Attitude (20, 48, 49), food preferences (50), parent dietary behaviors (51–53), and other factors that influence dietary intake were not included in this analysis but might have played a role in the results. Further research can examine how these factors impact nutrition knowledge.

Another potential limitation of this analysis is the use of grams (e.g., <50 g) rather than a percentage of total daily calories (e.g., <10%) when assessing nutrition knowledge of added sugar recommendations. It is also possible that other answer choices aside from (<50 g) could have been correct for some adult respondents whose caloric intake is >2000 calories per day, because daily calorie needs vary from person to person and are based on gender, body size, age, and activity level. However, it was expected that participants would be unfamiliar with the <10% of total daily calories recommendation from the 2015–2020 DGA (11) and instead would be more familiar with a 50-g (based on a 2000-calorie diet) recommendation frequently used in consumer-facing public health materials as well as on the Nutrition Facts Labels of all foods and beverages (3).

The answer choice "less than 50 grams" of added sugar per day was also the lowest number provided as an option and participants might have selected this option because most individuals negatively perceive added sugar (49, 54). We believe this limitation was mitigated by the fact that "I don't know" was also an answer choice. This minimized the possibility of random guessing if the participant did not know the answer. Overall, the majority of students and parents selected the incorrect answer or indicated that they did not know. These findings contribute to a growing body of literature indicating a lack of knowledge about DGA recommendations, suggesting the need for more education in this area (55).

This analysis examined relations between parent and child knowledge of added sugar recommendations and their associations with added sugar intake in elementary-aged children. Child knowledge of added sugar recommendations was significantly associated with lower child added sugar intake. The low percentage of children that correctly

TABLE 5 Mixed effect linear regression of the association between child and parent knowledge of added sugar recommendations and a child's average added sugar intake ($n = 685$)

	Standardized β	SE	95% CI for β	*P* value
Child demographics				
Sex				0.88
Female	Referent	—	—	
Male	0.29	2.05	−3.74, 4.32	0.88
Age				0.10
≥11 y	Referent	—	—	
10 y	2.74	4.12	−5.36, 10.84	0.51
9 y	−3.33	4.08	−11.34, 4.67	0.41
≤8 y	−1.16	4.28	−9.56, 7.24	0.79
Ethnicity/race				0.24
Hispanic or Latino	Referent	—	—	
Non-Hispanic white	7.67	4.37	−0.91, 16.25	0.08
Non-Hispanic black	6.46	6.18	−5.68, 18.60	0.30
Other	−1.01	6.08	−12.95, 10.93	0.87
Parent demographics				
Sex				0.12
Female	Referent	—	—	
Male	−5.19	3.30	−11.67, 1.29	0.12
Ethnicity/race				0.89
Hispanic or Latino	Referent	—	—	
Non-Hispanic white	3.29	4.21	−4.97, 11.55	0.43
Non-Hispanic black	2.50	6.70	−10.65, 15.65	0.71
Other	2.82	8.74	−14.34, 19.99	0.75
Educational attainment				0.29
Graduate or professional training	Referent	—	—	
College graduate	0.98	4.83	−8.50, 10.46	0.84
Some college or vocational school	0.72	4.69	−8.49, 9.94	0.88
High-school graduate/General	−1.18	4.94	−10.89, 8.52	0.81
Educational Development				
Some high school	7.84	5.72	−3.40, 19.08	0.17
No high school	2.99	5.87	−8.54, 14.51	0.61
Knowledge of added sugar recommendations				
Child knowledge				0.003
Incorrect	Referent	—	—	
Correct	−6.19	2.08	−10.28, −2.10	0.003
Parent knowledge				0.12
Incorrect	Referent	—	—	
Correct	−3.24	2.08	−7.33, 0.86	0.12

identified the added sugar recommendation indicates that further efforts in nutrition education are warranted. These findings also suggest the need for more outreach targeting nutrition knowledge in low-income child populations. Future research should investigate a causal relation between added sugar knowledge following nutrition education and intake in elementary-aged children.

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