

Dental Health and School Lunch:

Investigating the Link between Caries and Consumption

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ABSTRACT

Purpose: To examine an association between school lunch consumption and dental caries experience in US pediatric population.

Methods: Data obtained from NHANES 2013-2018 were analyzed. The study-sample included 7,163 individuals representing ~54.77 million four to 19-years old school-going children and adolescents in the United States. The school lunch consumption was the independent variable, which was measured by its weekly frequency. The outcome of interest was dental caries experience, determined by presence of ≥1 decayed, restored, and/or missing teeth. Log-binomial regression analysis was conducted to determine the association between school lunch consumption and dental caries experience.

Results: The highest prevalence of dental caries experience was observed amongst children always consuming school-provided lunches (55%), followed by occasional consumption (46%), and the least amongst those who never consumed (43%) (P-value <.0001). After controlling for demographic, socioeconomic and household factors, insurance coverage, and oral health behaviors including: last dental visit, systemic fluoride intake, and oral hygiene practices, the prevalence ratio was 0.82 (95% CI: 0.72 - 0.93) and 0.89 (95% CI: 0.80 - 0.99) for those who “never” and “sometimes” consumed school lunch respectively in reference to those individuals who “always” consumed school lunch.

Conclusion: Children and adolescents who never consumed school lunch were less likely to experience dental caries compared to those who consumed either daily or sometimes. The study underscores a critical need to address the cariogenic potential of school meals for oral health promotion and well-being of children and adolescents in the United States.

MATERIALS AND METHODS

A population-based cross-sectional study was conducted by analyzing publicly available, deidentified data obtained from a nationally representative sample of the individuals who participated in the National Health and Nutrition Examination Survey (NHANES), 2013-2018. NHANES is conducted by the Centers for Disease Control and Prevention’s National Center for Health Statistics, collecting data from children and adults, including interviews on health, diet and demographics. Laboratory tests, dental and physical exams were also completed for these participants for use in research and public policy work as well as to determine the prevalence and risk factors for diseases.¹⁷ Our study-sample included 7,163 individuals representing approximately 54,775,333 children and adolescents.

Primary Exposure: Participants were asked, “During the school year, about how many times a week do you usually get a complete school lunch?” as part of the Diet, Behavior, and Nutrition section. The question referred specifically to complete lunches provided by the school, with responses ranging from 0 to 5 days per week. For participants younger than 16 years, responses were obtained from a proxy respondent (either parent or caregiver). For this analysis, school lunch consumption was categorized as follows: 0 days per week as “Never”, 1 to 4 days per week as “Sometimes”, 5 days per week as “Always”. Additionally, those participants who attended schools which did not offer school lunches were also classified as “Never”.

Outcome of Interest: Dental caries experience was the outcome of interest. It was a dichotomous variable classifying the participants into either Yes or No category. Participants who had ≥ 1teeth decayed, restored, and/or missing due to dental disease were classified to have dental caries experience. Those who did not have any decayed, restored, and/or missing teeth due to dental disease were classified into “No” category.

Covariates: The list of covariates included the study-participants’ age, sex, race and ethnicity, country of birth, family income-to-poverty ratio, diabetes, last dental visit, prescription fluoride drops and/or tablets, tooth brushing frequency, health insurance, household reference person’s education, household reference person’s marital status, and household smoking.

Statistical Analysis: Unadjusted and adjusted log-binomial regression models were constructed to determine the association between school lunch consumption and dental caries experience. The final adjusted model controlled for participants’ age, sex, race and ethnicity, country of birth, family income-to-poverty ratio, diabetes status, last dental visit, use of prescription fluoride drops and/or tablets, tooth brushing frequency, health insurance coverage, household reference person’s education level, household reference person’s marital status, and household smoking status. Prevalence ratios (PRs) and corresponding 95% confidence intervals (CIs) were computed from unadjusted and adjusted models.

RESULTS

Participant characteristics and school lunch consumption patterns are presented in Table 1. Overall, on a weekly basis, 55.3% of children reported “always”, 18.8% “sometimes”, and 25.9% “never” consuming school lunch. The mean age of participants was 11.4 years. Children aged four to five years comprised 6.7%, six to 11 years 43.9%, and 12 to 19 years 49.4% of the population.

Children who never consumed school lunch were more likely to be aged 12 to 19 years (55.5%). Significant differences were observed by sex, with males more likely than females to always consume school lunch (54.5% vs. 45.5%; P < .0001). Non-Hispanic White children comprised 66.5% of those who “never” consumed school lunch. Among children who “always” consumed school lunch, 39.6% identified as Non-Hispanic White, 21.2% as Hispanic, 18.3% as Non-Hispanic Black, 10.4% as Other Hispanic, and 10.6% as Other or Multiracial.

Overall, 22.4% of participants had a family income-to-poverty ratio of less than one. Of those who “always” consumed school lunch 32.3% had an income-to-poverty ratio of less than one. “Always” consuming school lunch was also more common among children from households with lower education attainment [less than high school (24.9%) and high school grad/some college (56.8%)] whereas children from households with a college education or higher were more likely to “never” consume school lunch (28.9%).

Oral health characteristics differed by school lunch consumption. Children who “never” consumed school lunch were most likely to be rated as having excellent or very good teeth and gum condition (94.3%). Dental caries experience was present in 50.0% of the total sample and was significantly more prevalent among children who “always” consumed school lunch (54.7%; P < .0001). Children who “always” consumed school lunch were likely to reside in households with tobacco product use (30.3%; P < .0001). Daily toothbrushing was consistent across all categories.

No significant differences by school lunch consumption were observed for diabetes status, time since last dental visit, prescription fluoride use, daily tooth brushing frequency, or health insurance coverage (P > .05).

Prevalence ratios for the association between school lunch consumption and dental caries are presented in Table 2. In unadjusted analyses, children who “never” or “sometimes” consumed school lunch had a lower prevalence of dental caries compared with those who “always” consumed school lunch (PR = 0.79; 95% CI: 0.71-0.87 and PR = 0.84; 95% CI: 0.77-0.92, respectively). After partial adjustment for age, sex, race and ethnicity, country of birth, and family income-to-poverty ratio, the association remained attenuated but statistically significant for children who “never” consumed school lunch (PR = 0.84; 95% CI: 0.76-0.92), while the estimate for those who “sometimes” consumed school lunch approached the null (PR = 0.92; 95% CI: 0.84-1.00).

In the fully adjusted model -including demographic characteristics, diabetes status, last dental visit, prescription fluoride use, toothbrushing frequency, health insurance coverage, household reference person’s education and marital status, and household smoking- children who “never” or “sometimes” consumed school lunch continued to show a lower prevalence of dental caries compared with those who “always” consumed school lunch (PR = 0.82; 95% CI: 0.72-0.93 and PR = 0.89; 95% CI: 0.80-0.99, respectively). The analytic sample included 6,529 participants, representing a weighted population of 50,760,385.

CONCLUSIONS

Based on this study’s results, the following conclusions can be made:

1. Significant association exists between consumption of school lunch and dental caries experience in US school-aged children.
2. This study underscores the urgency to improve the nutritional quality of school lunches by reducing cariogenic potential while continuing to support the broader dietary requirements of children in school settings.
3. Findings from this study highlight a critical need for integrating oral health considerations into school nutrition policies as a public health opportunity to potentially reduce the burden of dental caries and promote oral health.

INTRODUCTION

The 2010 Healthy, Hunger-Free Kids Act (HHFKA) enacted by the United States Congress, aimed to align school meals with Dietary Guidelines for Americans, mandating healthier meal options beginning in the 2012 school year.^{1,2} While school lunch and breakfast are available to all students at public schools, the National School Lunch Program (NSLP) serves over 30 million students of low socioeconomic status, giving access to free and reduced-cost school meals.³ Children enrolled in the NSLP consume 47% of their daily calories at school.^{3,4} Following HHFKA implementation, food quality improved for participants of NSLP compared to non-participants.⁵ Mandated changes introduced more fruits, vegetables, whole grains, low-fat milk, and limits on sodium and calories, leading to greater meal variety, including more salad options, and removal of high-fat toppings.^{3,6,7}

Participation in the program is often used as a proxy of low socioeconomic status, a known risk factor for dental caries, the most common chronic childhood disease.^{3,8} Increased NSLP enrollment correlated with less dental treatment; however, caries presence was more strongly linked to race/ethnicity than to school poverty or NSLP participation.^{9,10} Following HHFKA implementation, school meal consumption was shown to increase overall diet quality and quality of food, regardless of the poverty level of the school.^{6,11,12} Caries leads to more hospitalizations, missed school days, diminished ability to learn, and reduced oral health related quality of life.¹³

Lack of availability of nutritious food, food insecurity and malnutrition can contribute to unhealthy eating habits, increasing risk of caries and obesity.¹⁴ Increased access to healthy food during school meals improved student dietary intake, reduced food insecurity and enhanced academic performance.^{4,15,16} The purpose of this study was to determine the association of school lunch consumption with dental caries experience in school aged children whose dietary patterns align most closely with the US Dietary Guidelines for Americans.

Table 1. Characteristics of the study-sample: US Children: four to 19-years old, overall and by school lunch consumption, NHANES 2013-2018

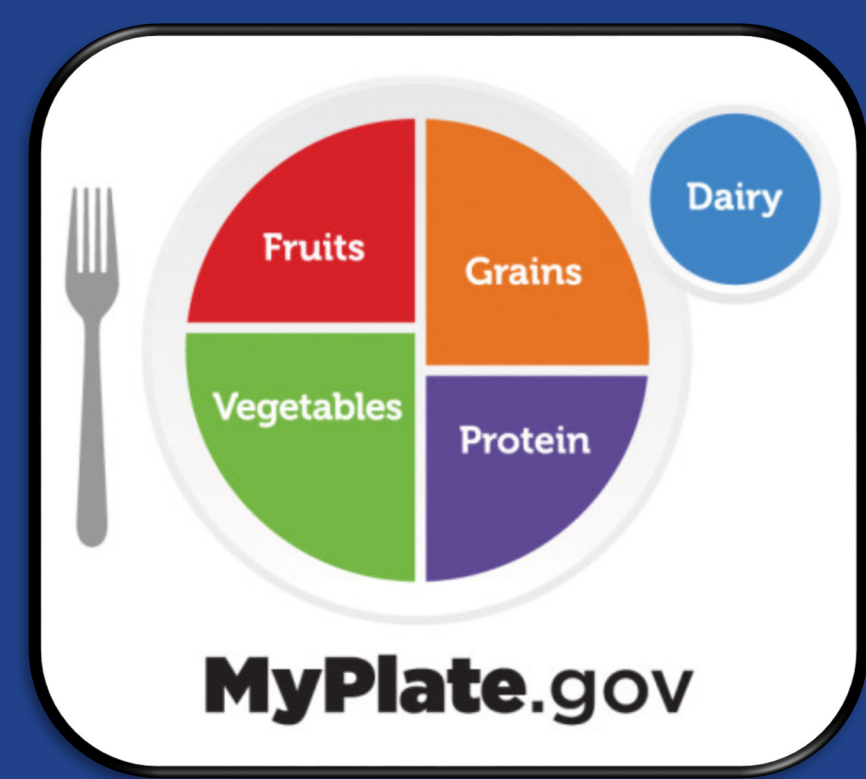
Characteristics	Total population		School lunch consumption						P-value†
	N	%**	Never		Sometimes		Always		
	1,047 (54,775,333)	100	1,042 (54,208,807)	25.98	1,156 (12,203,416)	18.77	4,587 (20,262,091)	55.25	<0.0001
	N	%	N	%	N	%	N	%	
Age groups									
4-5 years old	554	6.7	239	42.9	32	5.8	283	51.3	<0.0001
6-11 years old	3093	30.0	1418	45.8	464	15.0	1211	39.2	
12-19 years old	3076	30.4	155	5.0	487	15.8	1434	46.7	
Gender									
Male	3632	35.0	151	4.1	490	15.6	1491	44.3	<0.0001
Female	3551	34.9	407	11.5	749	21.1	1495	42.5	
Race/Ethnicity									
Hispanic	1531	14.6	97	6.3	318	20.8	1116	72.9	<0.0001
Other Hispanic	756	7.2	49	6.5	163	21.4	544	72.1	
Non-Hispanic White	1878	18.0	66.5	3.5	59.4	3.2	39.6	2.1	
Non-Hispanic Black	1773	16.9	7.4	0.4	11.9	0.7	18.3	1.0	
Other Hispanic	1229	11.7	11.5	0.9	11.4	0.9	10.6	0.8	
Country of birth									
U.S. born	6619	63.5	95.6	1.4	95.5	1.4	93.7	1.4	<0.0001
Foreign born	543	5.2	4.4	0.8	4.3	0.8	6.3	1.2	
Household reference person's education level									
High School	3665	35.0	18.9	0.5	12.1	0.3	24.9	0.7	<0.0001
High School Grad/GED or Some college or higher	3698	35.2	45.0	1.2	48.9	1.3	56.8	1.5	
College degree or higher	1543	14.6	28.9	0.8	39.0	1.1	51.4	1.4	
Family income: Poverty ratio									
Poverty Ratio < 1	2000	19.1	22.4	0.6	12.7	0.4	32.3	0.9	<0.0001
Poverty Ratio ≥ 1	4499	42.9	27.6	0.8	87.2	2.5	67.7	1.9	
Household reference person's marital status									
Married/Living with Partner	4979	47.6	74.9	2.1	71.8	2.1	70.9	2.1	<0.0001
Widowed/Divorced/Separated	1263	12.0	16.5	0.5	16.5	0.5	18.0	0.5	
Never Married	4212	40.4	8.6	0.2	8.8	0.2	11.1	0.3	
Disability									
Yes	30	0.3	0.9	0.0	0.3	0.0	0.6	0.0	0.53
No	7092	68.0	98.8	2.8	99.4	2.8	98.9	2.8	
Diastemate	31	0.3	0.3	0.0	0.3	0.0	0.3	0.0	
Last Dental Visit									
Within one year	4000	38.3	40.2	1.1	40.2	1.1	41.1	1.1	0.06
More than 1 year ago but no more than 1 year ago	769	7.3	9.1	0.2	8.7	0.2	11.3	0.3	
More than 2 years ago	106	1.0	1.1	0.0	1.1	0.0	2.4	0.0	
Never	200	1.9	2.1	0.0	2.1	0.0	2.2	0.0	
Prescription Fluoride (drops/tablets)									
Yes	445	4.2	13.6	0.4	16.2	0.5	12.5	0.4	0.10
No	529	5.0	30.4	0.8	35.8	1.0	37.5	1.0	
Daily tooth brushing									
Brushes Every day	7011	66.8	98.8	2.8	98.8	2.8	97.7	2.8	<0.0001
Does not brush yet or not applicable	150	1.4	2.2	0.0	2.3	0.0	2.3	0.0	
Condition of teeth and gums									
Excellent/Very Good	4271	40.8	46.3	1.3	52.4	1.5	36	0.1	<0.0001
Fair	760	7.2	5.0	0.1	6.7	0.2	12.0	0.3	
Poor	128	1.2	1.5	0.0	1.7	0.0	2.0	0.0	
Health insurance coverage									
Yes	4626	44.2	93.8	2.7	93.8	2.7	93.4	2.7	0.22
No	515	4.9	8.2	0.2	8.1	0.2	6.6	0.2	
Living in a household where one or more members smoke cigarettes, pipes, little cigars, cigars, water pipes, hookah, or any other tobacco product									
Yes	497	4.7	21.6	0.6	18.2	0.5	20.3	0.6	<0.0001
No	5150	49.4	11.8	0.3	11.8	0.3	10.7	0.3	
Dental Caries Experience									
Yes	3601	34.4	30.0	0.9	41.0	1.2	51.9	1.5	<0.0001
No	3262	31.2	30.0	0.9	34.1	1.0	45.3	1.3	
Body Mass Index (BMI) (mean) ± SD									
Age	Mean†	sd‡	Mean†	sd‡	Mean†	sd‡	Mean†	sd‡	
11.4	0.1	11.2	0.2	11.3	0.2	11.0	0.2	<0.0001	
Mean†	sd‡	Mean†	sd‡	Mean†	sd‡	Mean†	sd‡		
21	0.1	20.9	0.2	20.8	0.3	21.1	0.1	0.4	

† raw sample size, ** weighted column percentages, † weighted sample, ‡ Chi-square statistics except age and BMI (ANOVA), § weighted row percentages, § Computed using available data; totals may vary due to missing values, †† mean: weighted average, ††† se: weighted standard error

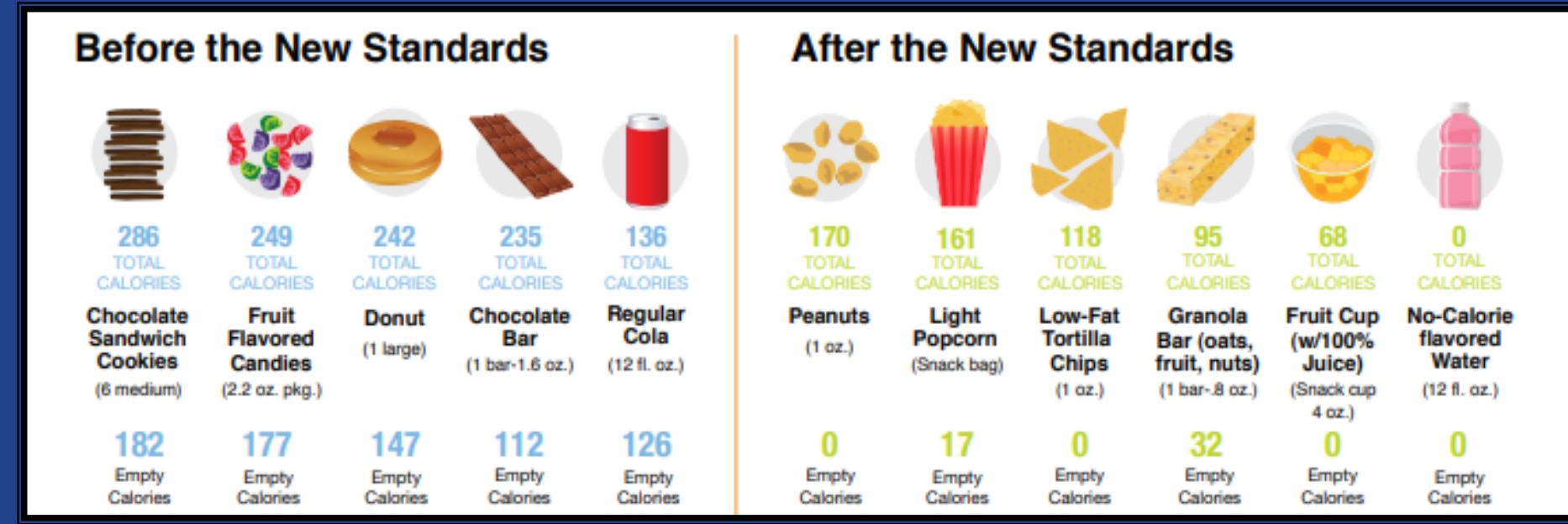
Table 2. Association between School lunch consumption and dental caries experience in a sample of four to 19-years old children and adolescents in the United States, NHANES 2013-2018

Model	School lunch consumption	Odds ratio (95% CI)	95% confidence interval (CI)	Unweighted N	Weighted sample	P-value
1*	Never	0.79	0.71-0.87	7,163	54,775,332	<0.0001
	Sometimes	0.84	0.77-0.92			
	Always	Reference				
2**	Never	0.84	0.76-0.92	6,529	50,760,385	0.0017
	Sometimes	0.92	0.84-1.00			
	Always	Reference				
3†	Never	0.82	0.72-0.93	5,232	39,585,936	0.0039
	Sometimes	0.89	0.80-0.99			
	Always	Reference				

*Model 1: Non-adjusted.
 **Model 2: Adjusted for age, sex, race and ethnicity, country of birth, and family income to poverty ratio
 †Model 3: Adjusted for age, sex, race and ethnicity, country of birth, family income to poverty ratio, diabetes, last dental visit, prescription fluoride drops and/or tablets, tooth brushing, health insurance coverage, household reference person’s education, household reference person’s marital status, and household smoking



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