

ASSOCIATION OF FOOD SECURITY WITH ORAL HEALTH OUTCOMES AMONG CHILDREN AND ADOLESCENTS: AN ANALYSIS OF NHANES DATA

Hesham A. Alhazmi¹

¹ Department of Preventive Dentistry, Faculty of Dentistry, Umm Al-Qura University, Makkah, Saudi Arabia

Corresponding author: Hesham A. Alhazmi- haahazmi@uqu.edu.sa

ABSTRACT

Aim of the study This study aims to assess the relationship between food security and unmet dental needs, as well as previous dental caries experience, among children and adolescents aged 6 to 18 utilizing National Health and Nutrition Examination Survey (NHANES) data. **Materials and methods** This study utilized NHANES data from 2015 to 2018. The primary outcomes measured were dental caries experience through the Decayed, Missing, and Filled Teeth (DMFT) index and untreated dental caries. Analyses examined the relationship between these outcomes and food security status, as well as demographic and health-related variables. Chi-square tests and negative binomial regression analyses, were utilized to analyse the data, reporting mean ratios, with a significance threshold set at $p < 0.05$. **Results** This study included 5,063 participants, with the majority (87.28%) experiencing full to marginal food security. Individuals not receiving Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) benefits reported a mean of untreated dental caries of 0.13 (95% CI: 0.10-0.16) for full to marginal food security and a higher mean of 0.23 (95% CI: 0.12-0.35) for low to very low food security. Additionally, individuals experiencing low to very low food security had a mean ratio of 1.27 ($p < 0.05$; 95% CI: 1.05-1.53) in DMFT scores compared to those with full to marginal food security. **Conclusions** The study highlights that individuals and adolescents experiencing low to very low food security have higher levels of untreated dental caries and DMFT scores. The findings underscore the importance of addressing food insecurity to promote for better oral health outcomes in paediatric populations. Tackling these disparities might help for improving the overall health and well-being of children and adolescents.

KEY WORDS: Food security, dental caries

INTRODUCTION

Oral health conditions represent a significant global health challenge. In 2017, more than three billion cases of oral conditions were reported. In the United States, the prevalence of dental caries among children in 2016 was 45.8% (1). Dental caries and dental abscesses impact children's quality of life and affect their self-esteem (2). Several factors influence the prevalence of caries. Reports indicate that the incidence of dental caries increases with age, and non-Hispanic Black children and Hispanic children exhibit a higher prevalence of dental caries compared to non-Hispanic White children (3). Inadequate food access is another factor that may influence the prevalence of caries,

defined as the "limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways" (4).

A study utilizing the 2011-2012 the National Health and Nutrition Examination Survey (NHANES) data assessed the relationship between food insecurity and dental caries among US adults. It included over ten thousand participants and found that the odds of having dental caries were higher among adults who reported food insecurity compared to those who were food secure (5). Brittney Hill evaluated the relationship between dental caries and food security among children using the 2012-2015

NHANES data. More than four thousand children were included in the study, which concluded that children categorized as having low food security had higher odds of dental caries compared to those with higher food security status (6). Another study conducted by Sanjeevi et al. focused on assessing the impact of the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) on the relationship between food security and dental caries among children under five years of age. They included 1,921 participants and reported that the odds of dental caries were higher among children with lower food security status, specifically for those who were non-participants in the WIC program compared to children with higher food security status (7). Chi et al. examined the association of dental caries and food security across different socioeconomic status groups using the NHANES data. They found that the prevalence ratio of dental caries was lower among children with higher socioeconomic status and those with higher food security status (8).

The growing concern regarding oral health disparities, particularly among vulnerable populations, underscores the significance of examining the relationship between food security and dental health (9). Previous studies utilizing NHANES data have predominantly focused on adults and younger children, showing associations between food insecurity and the prevalence of dental caries, as well as previous dental caries experience indicated by the Decayed, Missing, and Filled Teeth (DMFT) index (3,6). However, there remains a gap in research specifically targeting children and adolescents aged 6 to 18. The aim of this study was to assess the relationship between food security and unmet dental needs, as represented by untreated dental caries, alongside previous dental caries experience measured by the DMFT index

among this age group.

MATERIALS AND METHODS

Data were extracted from the NHANES database (10). NHANES is a comprehensive survey designed to assess the health and nutritional status of adults and children in the United States. Administered by the National Centre for Health Statistics (NCHS), NHANES combines interviews and clinical examinations to provide a detailed overview of health and dietary practices. For this study, data were extracted from the 2015-2018 NHANES cycles. The inclusion criteria focused on children and adolescents aged 6 to 18 who had undergone clinical examinations. The primary outcomes of this study were dental caries experience, measured through the DMFT index, and untreated dental caries. Both outcomes were treated as discrete variables. The main dependent variable in the analysis was the food security. This variable was coded as a binary variable (0=full to marginal food security status; 1=low to very low food security status). Additionally, several demographic and health-related variables were analysed, including gender (Boys and Girls), age group (6-11 years and 12-18 years), and race/ethnicity (Non-Hispanic White, Non-Hispanic Black, Hispanic, and Others). Access to dental care was also recorded, indicating whether individuals had visited a dentist (Yes or No). Furthermore, participation in the WIC was assessed. This variable was coded as binary, with responses categorized into 'Receiving' and 'Not receiving' benefits from the WIC program in the last 12 months. Statistical analysis was conducted using Stata 16 software. Count and weighted percentages were calculated for demographic and health-related variables, both overall and categorized by food security status. To assess

the relationship between food security and demographic/health-related variables, a Chi-square test was employed. Additionally, the mean of untreated dental caries was measured along with the 95% confidence interval (CI) for the various demographic and health-related variables. To evaluate the association between the DMFT index and food security status, negative binomial regression analyses were performed while controlling for potential confounders, including age, gender, race/ethnicity, dental visit history, and WIC participation. Mean ratios and their corresponding 95% CIs were reported for these associations. A p-value of 0.05 was established as the threshold for significance.

RESULTS

Table 1 presents the socio-demographic characteristics of the 5,063 participants categorized by food security status. The gender distribution is nearly balanced, with 50.78% boys (n=2,537) and 49.22% girls (n=2,526). The age breakdown indicates that 51.12% fall within the 12–18-year age group (n=2,232). In terms of race/ethnicity, 50.94% identified as Non-Hispanic White (NH White) (n=1,446), 13.76% as Non-Hispanic Black (NH Black) (n=1,165), 24.09% as Hispanic (n=1,545), and 11.21% as belonging to other ethnicities (n=907). Regarding dental visits, 84.28% reported having seen a dentist (n=4,212) and 13.77% of participants were receiving WIC benefits (n=897). Overall, 87.28% of participants reported full to marginal food security. Among the gender categories, 13.49% of girls had low to very low food security, compared to 11.99% of boys. In the age group analysis, the 12–18-year category had a higher percentage of low to very low food security at 12.49%, whereas the 6–11 age group reported 12.95%. Regarding race/ethnicity, Hispanic participants

exhibited the highest percentage of low to very low food security at 18.07%. Among those who visited a dentist, 18.48% of participants who had not sought dental care reported low to very low food security. Lastly, within the WIC categories, 21.94% of participants receiving benefits experienced low to very low food security, in contrast to 11.42% of those not receiving benefits. The relationships between food security and other variables were found to be significant (<0.05), except for age and gender, which showed no significant differences.

Table 2 presents the mean untreated dental caries among participants based on different socio-demographic characteristics. The overall mean untreated dental caries for all participants was 0.14 (95% CI: 0.11-0.17). For gender, both boys and girls reported a similar mean of 0.14 (95% CI: 0.11-0.17). In terms of age, participants aged 12–18 years had a higher mean of 0.22 (95% CI: 0.18-0.26), compared to a mean of only 0.05 (95% CI: 0.03-0.07) for the 6–11-year age group. Regarding race/ethnicity, Non-Hispanic Black participants exhibited the highest mean untreated dental caries at 0.19 (95% CI: 0.12-0.26). In relation to dental visits, participants who did not visit a dentist had a higher mean of 0.34 (95% CI: 0.26-0.42), compared to a lower mean of 0.10 (95% CI: 0.08-0.13) for those who did visit a dentist. Concerning WIC participation, those receiving benefits had a mean of 0.13 (95% CI: 0.08-0.18), while those not receiving benefits had a slightly higher mean of 0.14 (95% CI: 0.12-0.17). The overall mean untreated dental caries for participants with full to marginal food security was 0.12 (95% CI: 0.10-0.16), whereas those experiencing low to very low food security had a mean of 0.21 (95% CI: 0.12-0.30). Regarding race/ethnicity, Non-Hispanic White participants had a mean untreated dental caries of 0.11 (95% CI: 0.08-

0.15) for full to marginal food security but reported a much higher mean of 0.26 (95% CI: 0.09-0.43) for low to very low food security. In relation to dental visits, participants who did not visit a dentist had a significantly higher mean of 0.31 (95% CI: 0.22-0.41) for full to marginal food security and 0.46 (95% CI: 0.20-0.73) for low to very low food security. Lastly, concerning WIC participation, participants receiving benefits had a mean untreated dental caries of 0.13 (95% CI: 0.07-0.19) for full to marginal food security and 0.15 (95% CI: 0.06-0.24) for low to very low food security. Those not receiving benefits reported a mean of 0.13 (95% CI: 0.10-0.16) for full to marginal food security and a higher mean of 0.23 (95% CI: 0.12-0.35) for low to very low food security.

Table 3 presents the relationship between DMFT scores and food security status as a primary predictor. Participants with low to very low food security exhibited a mean ratio of 1.27 compared to those with full to marginal food security, indicating a 27% higher DMFT score, which is statistically significant ($p < 0.05$; 95% CI: 1.05-1.53).

DISCUSSIONS

This cross-sectional study focused on children and adolescents aged 6 to 18 to assess the relationship between food security and dental caries. Individuals with low to very low food security status exhibited a higher mean of untreated dental caries compared to those with full to marginal food security. This finding aligns with a previous study targeting children under 5 years of age (7). Our study further evaluated the mean of untreated dental caries across various demographic and health-related variables. Among individuals with low to very low food security status, those who did not have a dental visit in the past year had a higher mean of untreated dental caries compared to their

counterparts who visited a dentist. Additionally, individuals who did not receive WIC benefits had a higher mean of untreated dental caries compared to those who did receive WIC benefits. Fisher-Owens et al. examined disparities in children's oral health in the United States, concluding that several socioeconomic variables may contribute to these disparities, and emphasized the need for efforts to close the gap (11). Moreover, a study utilizing NHANES data assessed the relationship between socioeconomic variables and oral health status among children, finding that children from low-income families had higher odds of untreated dental caries compared to those from higher-income families. This study recommended tailored initiatives to ensure vulnerable populations are not overlooked (12).

This study assessed caries experience using the DMFT score and demonstrated that individuals with low to very low food security status had a higher mean ratio of DMFT compared to those with full to marginal food security status. This finding is consistent with a previous study that examined the association between food security and early childhood caries in children under 5 years of age, which found that children facing higher food insecurity had elevated DMFT scores (13). A systematic review and meta-analysis, encompassing 10 studies, confirmed that food insecurity is linked to dental caries, indicating that efforts to reduce food insecurity could positively impact the prevalence of dental caries (14). The literature has examined various types of food to assess their association with dental caries. For instance, one study found that high yogurt intake among children and adolescents may decrease the risk of dental caries (15). Another study evaluated the impact of physical activity and calcium consumption among children and adolescents, uncovering

a potential positive effect on dental caries (16). Additionally, research explored the relationship between dental caries and flavonoid intake, concluding that children with higher flavonoid intake had lower odds of developing dental caries (17). The association between obesity and dental caries has been evaluated in several articles. One study concluded that there is no direct association between obesity and dental caries among children (18), while another suggested a potential association, noting that this may depend on how obesity is defined (19). Furthermore, diabetic adolescents were shown to have higher odds of dental caries compared to their non-diabetic peers (20). Individuals experiencing food insecurity are more prone to oral health issues, potentially linked to dietary habits influenced by income and other structural factors (21).

The results of this study should be interpreted with caution due to several limitations. First, most of the questions in the study were self-reported, which may introduce bias, such as recall bias. Second, the cross-sectional study design limits the ability to establish causal relationships. Despite these limitations, the study possesses some strengths, including the use of national data that encompasses a relatively large and representative population. It includes children and adolescents aged 6 to 18 and assesses dental caries experience across various demographics. Furthermore, it incorporates different demographic and health-related variables, facilitating a comprehensive analysis of dental health trends. The findings suggest that addressing food insecurity might help improve dental health among vulnerable populations. Policy initiatives aimed at increasing access to nutritious food and

dental care could be beneficial in reducing the incidence of untreated dental caries, thereby enhancing the overall well-being of at-risk children. Future research might need to focus on longitudinal studies that can establish relationships between food security and dental health over time. Moreover, in-depth investigations into specific dietary factors, such as the types and quantities of foods consumed, and their direct effects on oral health are warranted. Additionally, examining the impact of socio-economic interventions, such as WIC and other nutrition assistance programs, on dental health outcomes can provide further insights. Lastly, exploring the role of education and awareness campaigns regarding the importance of dental care among families facing food insecurity may prove beneficial in mitigating the negative effects observed in this study.

CONCLUSIONS

This study highlights the relationship between food security and dental health among children and adolescents aged 6 to 18. It reveals that low to very low food security is associated with a higher mean ratio of untreated dental caries. Targeted interventions and policy changes might help to enhance access to nutritious food and dental care for vulnerable populations. A multifaceted approach might be helpful for fostering better dental health in children and adolescents and closing the existing gaps in health disparities.

DISCLOSURE

The author reports no conflicts of interest in this work.

Table 1 Socio-Demographic and Health-Related Characteristics of U.S. Children and adolescents by Food Security Status: NHANES 2015-2018

Variables	Total (n=5063)	Weighted proportions %	Food Security Weighted proportions %		P-value ^b
Gender			Full to marginal (87.28%)	Low to very low (12.72%)	
Boys	2,537	50.78	88.01	11.99	0.11
Girls	2,526	49.22	86.51	13.49	
Age (years)					
6-11	2,831	48.88	87.05	12.95	0.68
12-18	2,232	51.12	87.51	12.49	
Race/Ethnicity					
NH* White	1,446	50.94	89.89	10.11	<0.05
NH Black	1,165	13.76	84.04	15.96	
Hispanic	1,545	24.09	81.93	18.07	
Others	907	11.21	90.71	09.29	
Dental visit					
Yes	4,212	84.28	88.31	11.69	<0.05
No	840	15.72	81.52	18.48	
WIC ^a category					
Receiving	897	13.77	78.06	21.94	<0.05
Not receiving	3,902	86.23	88.58	11.42	

*NH Non-Hispanic

^aWIC Special Supplemental Nutrition Program for Women, Infants, and Children

^bChi square test

Table 2 Mean Untreated Dental Caries by Socio-Demographic and Health Characteristics of U.S. Children and adolescents Across Food Security Status: NHANES 2015-2018

Variables	Total	Full to marginal food security	Low to very low food security
	Mean of untreated dental caries (95% CI)		
Total	0.14 (0.11-0.17)	0.12 (0.10-0.16)	0.21 (0.12-0.30)
Gender			
Boys	0.14 (0.11-0.17)	0.12 (0.09-0.15)	0.20 (0.09-0.31)
Girls	0.14 (0.11-0.17)	0.14 (0.10-0.17)	0.22 (0.1-0.34)
Age (years)			
6-11	0.05 (0.03-0.07)	0.04 (0.03-0.07)	0.09(0.01-0.16)
12-18	0.22 (0.18-0.26)	0.20 (0.16-0.25)	0.32 (0.17-0.49)
Race/Ethnicity			
NH* White	0.13 (0.10-0.17)	0.11 (0.08-0.15)	0.26 (0.09-0.43)
NH Black	0.19 (0.12-0.26)	0.17 (0.10-0.25)	0.23 (0.07-0.40)
Hispanic	0.15 (0.09-0.20)	0.15 (0.09-0.20)	0.14 (0.07-0.20)
Others	0.12 (0.07-0.17)	.12 (0.06-0.17)	.23 (0.07-0.39)
Dental visit			
Yes	0.10 (0.08-0.13)	0.1 (0.07-0.122)	0.14 (0.08-0.19)
No	0.34 (0.26-0.42)	0.31 (0.22-0.41)	0.46 (0.20-0.73)
WIC ^a category			
Receiving	0.13 (0.08-0.18)	0.13 (0.07-0.19)	0.15 (0.06-0.24)
Not receiving	0.14 (0.12-0.17)	0.13 (0.10-0.16)	0.23 (0.12-0.35)

*NH Non-Hispanic

^aWIC Special Supplemental Nutrition Program for Women, Infants, and Children

Table 3 Decayed, Missing, and Filled Teeth Scores by Food Security Status Among U.S. Children and adolescents: NHANES 2015-2018

Variables	Reference	MR ^b	P-value	95% CI
Food security				
Low to very low	Full to marginal	1.27	<0.05	(1.05-1.53)
Gender				
Girls	Boys	1.26	<0.05	(1.06-1.48)
Age (years)				
12-18	6-11	7.41	<0.05	(6.23-8.81)
Race/Ethnicity				
NH* Black	NH White	1.49	<0.05	(1.09-2.03)
Hispanic	NH White	1.71	<0.05	(1.45-2.03)
Others	NH White	1.16	0.27	(0.88-1.52)
Dental visit				
No	Yes	1.20	<0.05	(1.01-1.43)
WIC ^a category				
Not receiving	Receiving	1.13	0.22	(0.93-1.38)

*NH Non-Hispanic

^aWIC Special Supplemental Nutrition Program for Women, Infants, and Children

^b MR Mean ratio

REFERENCES

1. Bernabe E, Marcenes W, Hernandez CR, Bailey J, Abreu LG, Alipour V, et al. Global, Regional, and National Levels and Trends in Burden of Oral Conditions from 1990 to 2017: A Systematic Analysis for the Global Burden of Disease 2017 Study. *J Dent Res*. 2020 Apr 2;99(4):362–73.
2. Alharbi A, Freeman R, Humphris G. Dental anxiety, child-oral health related quality of life and self- esteem in children and adolescents: a systematic review and meta-analysis. *Community Dent Health*. 2021 May 28;38(2):119–26.
3. Fleming E, Afful J. Prevalence of Total and Untreated Dental Caries Among Youth: United States, 2015-2016. *NCHS Data Brief*. 2018 Apr;(307):1–8.
4. Wiener RC, Sambamoorthi U, Shen C, Alwhaibi M, Findley P. Food Security and Unmet Dental Care Needs in Adults in the United States. *J Dent Hyg*. 2018 Jun;92(3):14–22.
5. Bahanan L, Singhal A, Zhao Y, Scott T, Kaye E. The association between food insecurity and dental caries among U.S. adults: Data from the National Health and Nutrition Examination survey. *Community Dent Oral Epidemiol*. 2021 Oct;49(5):464–70.
6. Hill B. Evaluating the association between food insecurity and dental caries in US children 1-19 years: results from the National Health and Nutrition Examination Survey (NHANES) 2013-2014. *J Public Health Dent*. 2020 Jan;80(1):14–7.
7. Sanjeevi N, Freeland-Graves JH, Wright GJ. Food Security Status, WIC Participation, and Early Childhood Caries in a Nationally Representative Sample of Children. *J Acad Nutr Diet*. 2023 Feb;123(2):276–83.
8. Chi DL, Masterson EE, Carle AC, Mancl LA, Coldwell SE. Socioeconomic status, food security, and dental caries in US children: mediation analyses of data from the National Health and Nutrition Examination Survey, 2007-2008. *Am J Public Health*. 2014 May;104(5):860–4.
9. Robison V, Wei L, Hsia J. Racial/Ethnic Disparities Among US Children and Adolescents in Use of Dental Care. *Prev Chronic Dis*. 2020 Jul 30;17:E71.
10. Centers for Disease Control and Prevention. About the National Health and Nutrition Examination Survey. Available at: <https://wwwn.cdc.gov/nchs/nhanes/continuousnhanes/default.aspx?BeginYear=2017> Accessed March 2 2025.
11. Fisher-Owens SA, Isong IA, Soobader MJ, Gansky SA, Weintraub JA, Platt LJ, et al. An examination of racial/ethnic disparities in children's oral health in the United States. *J Public Health Dent*. 2013;73(2):166–74.
12. Duffy EL, Kranz AM, Dick AW, Sorbero M, Stein BD. Association between type of health insurance and children's oral health, NHANES 2011-2014. *J Public Health Dent*. 2018 Sep;78(4):337–45.
13. Angelopoulou M V, Shanti SD, Gonzalez CD, Love A, Chaffin J. Association of food insecurity with early childhood caries. *J Public Health Dent*. 2019 Mar;79(2):102–8.

14. Sabbagh S, Mohammadi-Nasrabadi F, Ravaghi V, Azadi Mood K, Sarraf Shirazi A, Abedi AS, et al. Food insecurity and dental caries prevalence in children and adolescents: A systematic review and meta-analysis. *Int J Paediatr Dent*. 2023 Jul;33(4):346–63.
15. Wang J, Jin G, Gu K, Sun J, Zhang R, Jiang X. Association between milk and dairy product intake and the risk of dental caries in children and adolescents: NHANES 2011-2016. *Asia Pac J Clin Nutr*. 2021 Jun;30(2):283–90.
16. Zhang Q, Bai X, Jin H, Dong N. Combined effect of dietary calcium consumption and physical activity on dental caries in children and adolescents: a study of the NHANES database. *BMC Oral Health*. 2024 Feb 28;24(1):281.
17. Fan J, Liu S, Zhang Q, Qiao L, Chu Q. Association between flavonoids intake and dental caries in children and adolescents: a cross-sectional study from the NHANES database. *BMC Oral Health*. 2024 Jul 26;24(1):848.
18. Mohajeri A, Berg G, Watts A, Cheever VJ, Hung M. Obesity and Dental Caries in School Children. *J Clin Med*. 2024 Feb 1;13(3).
19. Piovesan ÉT de A, Leal SC, Bernabé E. The Relationship between Obesity and Childhood Dental Caries in the United States. *Int J Environ Res Public Health*. 2022 Dec 2;19(23).
20. Beheshti M, Badner V, Shah P, Margulis KS, Yeroshalmi F. Association of Diabetes and Dental Caries Among U.S. Adolescents in the NHANES Dataset. *Pediatr Dent*. 2021 Mar 15;43(2):123–8.
21. Drumond VZ, de Arruda JAA, Bernabé E, Mesquita RA, Abreu LG. Burden of dental caries in individuals experiencing food insecurity: a systematic review and meta-analysis. *Nutr Rev*. 2023 Nov 10;81(12):1525–55.