

# Food Security and Unmet Dental Care Needs in Adults in the United States

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### Abstract

**Purpose:** Low food security is potentially related to poor dental health and unmet dental care needs. Food security has become a significant public health concern in the United States (U.S.) since the Great Recession beginning in 2007. The purpose of this study is to determine the association between low food security and unmet dental care need in adults in the U.S.

**Methods:** A cross-sectional design with data from the National Health and Nutrition Examination Survey (NHANES) 2011-2012 was used for the study to measure unmet dental care need. The study population included 4,845 adults, ages 20 years and above. Chi square tests and logistic regressions were conducted for the statistical analysis.

**Results:** Overall, 47% of participants had unmet dental care need and 16% were found to have low food security. A higher percentage of adults with low food security had unmet dental care need (70.0% vs. 41.0%;  $p < .000$ ) as compared to adults with full food security. In adjusted analysis, adults with low food security were more likely to have unmet dental care need as compared to participants with full food security (Adjusted Odds Ratio, 1.58 [95% CI: 1.18, 2.12;  $p < .01$ ]).

**Conclusions:** A significant association between low food security and unmet dental care need was identified among adults in the United States. Dental professionals routinely provide community educational programs and regularly query patients about food intake due to its impact on oral and overall health. It is important for dental professionals to be able to discuss community food resource options or refer patients to social service providers to assist individuals with low food security.

**Keywords:** NHANES, National Health and Nutrition Examination Survey, food insecurity, dental care, unmet dental need

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### Introduction

The United States (U.S.) and Canada experienced sharp increases in the numbers of people reporting inadequate food beginning in the 1980's likely related to changes in the work-force, the nature of work and the compensation workers received.<sup>1</sup> The number of food banks also increased during that time period to meet the food needs of the population.<sup>1</sup> The term "food insecurity," defined as "limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways,"<sup>2</sup> was first introduced in 1990 and remains a significant social and public health concern today.<sup>3</sup> Although food insecurity has been an issue for generations of people, there has been an increase in food insecurity in the

U.S. beginning with the Great Recession of 2007 - 2009.<sup>4</sup> The concept of a food desert (an area of 500 people, or a census tract where 1/3 of the residents must travel more than one mile to a supermarket/large grocery store; or a rural area where the residents must travel more than ten miles to a supermarket/large grocery store) was introduced during this period and continues to be used to describe many geographic areas in the U.S.<sup>8</sup> Difficulty in food access often involves individual's settling for the foods that are available closer to one's home. Such options are often highly refined, calorie-laden, low-nutrient, less expensive foods with a long shelf-life. Lack of proper nutrition impacts health in many ways and there is the potential for food insecurity to be related not only to poor general health, but also to poor oral health.

One of the proposed mechanisms for the relationship between food insecurity and poor dental health is that a high carbohydrate load, particularly of highly refined carbohydrates, provides an oral environment conducive to the development of biofilms containing cariogenic bacteria.<sup>9-10</sup> It has been reported in the literature that children living in households with food insecurity were more likely to have untreated dental caries;<sup>11-12</sup> however, it is unknown if such an association exists *in adults*. In order to study the impact of food insecurity on unmet dental need in the adult population, the Andersen Behavioral Model of Health Services Usage was utilized.<sup>13</sup> This instrument provides a conceptual framework for studying vulnerable populations and health disparities. Under the Andersen model, increased service use or need for such use is determined by a number of factors broadly categorized as: immutable predisposing factors, enabling factors, and personal health practices. In this study, healthcare service need for *unmet* dental care was considered to be influenced by predisposing factors (e.g. sex; age; race or ethnicity), *not* having enabling factors (e.g. education; social support through marriage or partnership; adequate income; and *the interest of the study, food security*), and *not* having healthful personal health practices and/or conditions (e.g. smoking; alcohol use; previous dental visit over a year ago). The purpose of this study was to determine the association between low food security and unmet dental care needs in adults in the U.S.

## Methods

This study received institutional ethics acknowledgement and approval as non-human subject research (secondary data analysis of collected, publicly available data).

### Study design

An observational, retrospective, cross-sectional design with data obtained from the National Health and Nutrition Examination Survey (NHANES), 2011 and 2012, was used for the study.<sup>14</sup>

NHANES researchers from the Centers for Disease Control and Prevention (CDC) used stratified, multistage probability sampling designs for the surveys to select participants who were non-institutionalized civilians and lived in the U.S. (including Washington, DC).<sup>14</sup> The researchers oversampled smaller subgroups to increase estimate accuracy. Participants responded to interview questions involving demographic information and questions regarding health and nutrition. Data for the oral examination were collected in a mobile examination center by calibrated licensed dentists who received extensive and periodic training and re-calibration.

Details of the NHANES study methodology for 2011 and 2012 are available on the NHANES website.<sup>14</sup>

The study population sample was comprised of adults, age 20 years and above, who had no missing data in the areas of household food security, unmet dental care need, sex, race/ethnicity, and age from the NHANES 2011-12 and consisted of 4,845 participants.

### Measures studied

Unmet dental care need was the dependent variable. Individuals were considered to have an unmet dental care need if the NHANES dental examiner recommended that the participant be seen by a dentist. Conversely, individuals were considered to have no unmet dental care need if the examiner recommended that the participant continue with regular, routine care.

Food security was the key independent enabling variable. CDC researchers created a household food security variable in the NHANES 2011 and 2012 data sets based upon the U.S. Food Security Survey Module questions of Bickel, et al.<sup>15</sup> The 2011-12 survey contained 18 questions related to difficulties in food access, availability and quality for households with children; and 10 questions for households without children.<sup>15</sup> Affirmative responses to the food security module questions were tallied and categorized as shown in Table I. Households indicating no affirmative responses, were defined as having “full” food security. Households indicating 1-2 positive responses, were defined as having a “marginal” food security. Households without children under the age of 18 years, indicating 3-5 positive responses, or households with children under the age of 18 with 3-7 positive responses, were defined as having “low” food security. Households in which there were no children under the age of 18 years indicating 6-10 positive responses, or households with children and indicating 8-18 positive responses, were defined as having “very low” food security. If a household had children, but the respondent refused or did not answer the questions concerning the children, the household was classified using the criteria for households without children in the NHANES research. In the data analysis for this study, the categories “low” and “very low” food security were combined (due to small sample sizes) into the category of low food security.

A logistic regression model for the presence of unmet dental need was built incorporating other enabling variables (i.e., factors known to impact access to services), predisposing variables, and personal health practices and/or conditions. Additional enabling variables used in the study were: educational level (less than high school; high school

graduate; some college/technical school; college/technical school graduate or above), marital status (married; widowed/divorced/separated/never married); medical insurance (yes; no); family federal poverty ratio (0 to less than 1.25; 1.25 to less than 2.00; 2.00 to less than 4.00; 4.00 and above). The family federal poverty ratios listed here have been used in previous research,<sup>16</sup> however, the federal government does not have definitions related to low income, middle income, upper income, etc.

The predisposing variables used in this study included: sex (male; female), race/ethnicity (non-Hispanic White; non-Hispanic Black; Mexican-American or other), and age (20 to under 35; 35 to under 50; 50 to under 65; 65 and above). Personal health practices and/or conditions used in the study were smoking status (current smokers; former smokers; never smokers), body mass index (less than 25; 25 to less than 30; 30 and above), alcohol use (none; moderate [1-2 drinks per day]; heavy [more than 2 drinks per day]), and dental visits (within 6 months; within 1 to 2 years; more than 2 years).

### Statistical analyses

Chi square tests were used to examine the unadjusted association between dental care need, food security and the other independent variables. Logistic regression was used to examine the association between food security and dental care need with two different models: an unadjusted model and a model adjusted for predisposing factors, enabling factors, and personal health practices. All analyses included sampling weights to account for the complex NHANES survey design and were conducted using the Statistical Analysis System Software (SAS® version 9.3, SAS Institute, Inc.; Cary, NC, USA).

## Results

Descriptive sample characteristics are presented in Table II. Unmet dental need was identified in 47% of the adults in the sample and low food security was found in

16% of the sample population. The majority of the sample was non-Hispanic White (66.8%), married (61.6%) and insured (79.9%).

Sample results for unmet dental need are presented in Table III. The association of unmet dental care need for participants with low food security vs. those with full food security (70% vs. 41%) was significant ( $p < .0001$ ). There were also significant associations between unmet dental care need and the predisposing factors, enabling factors, and personal health practices/conditions. Unmet dental care need was reported by a higher percentage of non-Hispanic Black as compared to non-Hispanic White (66.3% vs. 40.2%), and adults living below the 1.25 times the family federal poverty level compared to adults living at or above 4.00 times the family federal poverty level (64.1% vs. 31.3%).

In the adjusted analysis, adults with low food security were more likely to report unmet dental care need as compared to adults with full food security (Adjusted Odds Ratio (AOR) = 1.58, 95% CI = 1.18, 2.12;  $P < .01$ ). Adjusted Odds Ratios and 95% confidence intervals for the other independent variables are presented in Table IV. Interaction analyses of food security with age, race/ethnicity, and federal poverty level supported the significant positive adjusted analysis association.

**Table I. Household Food Security Surveys: Difficulty in Food Access, Availability, and Quality**

Number of difficulty responses	Food Security Level: 4 categories	Food Security Level: 3 categories
0	full food security	full food security
1-2	marginal	marginal
3-5 (no child/children in household)	low	low
3-7 (with child/children in household)	low	low
3-5 (with child/children in household but no valid responses concerning the child/children)	low	low
6-10 (no child/children in household)	very low	low
8-18 (with child/children in household)	very low	low
6-10 (with child/children in household but no valid responses concerning the child/children)	very low	low

Based on 18 questions for households with a child or children under the age of 18 years, and 10 questions for households without a child or children or in which no valid responses concerning the child or children were provided. Questionnaire available from the Department of Agriculture<sup>15</sup> [www.ers.usda.gov/briefing/foodsecurity](http://www.ers.usda.gov/briefing/foodsecurity).

**Table II. Study Sample Characteristics National Health and Nutrition Examination Survey, 2011-2012**

	Unweighted Number	Weighted%
<b>All</b>	4,845	100
<b>Unmet Dental Care needs</b>		
Yes	2,678	47.1
No	2,167	52.9
<b>Household Food Security</b>		
Full	3,293	74.5
Marginal	572	9.7
Low	980	15.8
<b>Predisposing Factors</b>		
<b>Sex</b>		
Female	2,427	51.4
Male	2,418	48.6
<b>Race/Ethnicity</b>		
Non-Hispanic White	1,798	66.8
Non-Hispanic Black	1,277	11.3
Mexican American	463	7.5
Other Hispanic	488	6.5
Non-Hispanic Asian	674	5.1
Other races	145	2.7
<b>Age in years</b>		
20-34	1,312	27.8
35-49	1,228	27.7
50-64	1,255	27.1
65 and above	1,050	17.3
<b>Education Level</b>		
Less than high school	1,122	16.3
High school graduate	1,022	20.5
Some college	1,452	31.9
College degree and above	1,247	31.3

	Unweighted Number	Weighted%
<b>Enabling Factors</b>		
<b>Family Federal Poverty Level</b>		
0 to less than 1.25	1,507	21.7
1.25 to less than 2.00	772	14.7
2.00 to less 4.00	1,057	25.0
4.00 and above	1,128	32.9
<b>Married</b>		
Married	2,726	61.6
Widowed/separated/ divorced/never married	2,116	38.4
<b>Insurance</b>		
Insured	3,686	79.9
Uninsured	1,154	20.1
<b>Last Dental Visit</b>		
6 months to less than 1 year	2,599	60.3
1 year to less than 2 years	641	12.3
2 years and above	1,597	27.3
<b>Personal Health Practices</b>		
<b>Body Mass Index</b>		
Less than 25	1,525	30.6
25 to less than 30	1,564	33.8
30 and above	1,699	34.7
<b>Smoking Status</b>		
Current Smoker	973	19.9
Past Smoker	1,098	24.1
Never Smoke	2,769	56.0
<b>Alcohol Drinking</b>		
Non-drinker	1,159	18.3
Moderate	1,616	40.1
Heavy	1,094	25.0

Note: Based on 4,845 adults age 20 years and above with no missing information on dental care need and food security. Missing values for income, body mass index, and alcohol use are not reported in the table.

## Discussion

The purpose of this study was to examine the association between food security and unmet dental care need in adults. Adults with low food security were more likely to have unmet dental care need as compared with adults with full food

security. These findings are consistent with a Canadian study in which Muirhead et al. found that adults who reported food insecurity had poorer oral health and were more likely to be wearing dentures than adults who had food security.<sup>1</sup> Results of this study are also consistent with other studies among

**Table III. Dental Care Need National Health and Nutrition Examination Survey, 2011-2012**

	Unmet Dental Care Need		No Unmet Dental Care Need		p-value
	Number	Wt%	Number	Wt%	
<b>Household Food Security</b>					<b>&lt;.0001</b>
Full	1,626	41.0	1,667	59.0	
Marginal	369	56.6	203	43.4	
Low	683	70.0	297	30.0	
<b>Predisposing Factors</b>					
<b>Sex</b>					<b>&lt;.0001</b>
Female	1,188	40.2	1,239	59.8	
Male	1,490	54.4	928	45.6	
<b>Race/Ethnicity</b>					<b>&lt;.0001</b>
Non-Hispanic White	809	40.2	989	59.8	
Non-Hispanic Black	850	66.3	427	33.7	
Mexican American	319	67.9	144	32.1	
Other Hispanic	275	55.9	213	44.1	
Non-Hispanic Asian	350	51.1	324	48.9	
Other races	75	49.2	70	50.8	
<b>Age in years</b>					<b>0.002</b>
20-34	601	38.8	711	61.2	
35-49	725	50.8	503	49.2	
50-64	817	53.3	438	46.7	
65 and above	535	44.8	515	55.2	
<b>Education Level</b>					<b>&lt;.0001</b>
Less than high school	780	68.8	342	31.2	
High school	657	57.5	365	42.5	
Some college	787	47.9	665	52.1	
College degree and above	453	28.2	794	71.8	

	Unmet Dental Care Need		No Unmet Dental Care Need		p-value
	Number	Wt%	Number	Wt%	
<b>Enabling Factors</b>					
<b>Family Federal Poverty Level</b>					<b>&lt;.0001</b>
0 to less than 1.25	1,011	64.1	496	35.9	
1.25 to less than 2.00	474	56.8	298	43.2	
2.00 to less than 4.00	547	44.8	510	55.2	
4.00 and above	408	31.3	720	68.7	
<b>Marital Status</b>					<b>0.008</b>
Married	1,485	44.5	1,241	55.5	
Widowed/separated/divorced/never	1,191	51.2	925	48.8	
<b>Insurance</b>					<b>&lt;.0001</b>
Insured	1,865	42.1	1,821	57.9	
Uninsured	810	66.8	344	33.2	
<b>Last Dental Visit</b>					<b>&lt;.0001</b>
6 months to less than 1 year	1,178	36.3	1,421	63.7	
1 year to less than 2 years	399	58.3	242	41.7	
2 years and above	1,096	65.7	501	34.3	
<b>Personal Health Practices</b>					
<b>Body Mass Index</b>					<b>&lt;.0001</b>
Less than 25	746	40.2	779	59.8	
25 to less than 30	867	46.3	697	53.7	
30 and above	1,036	54.1	663	45.9	
<b>Smoking Status</b>					<b>&lt;.0001</b>
Current Smoker	694	67.3	279	32.7	
Past Smoker	579	45.7	519	54.3	
Never Smoke	1,400	40.5	1,369	59.5	
<b>Alcohol Drinking</b>					<b>&lt;.0001</b>
Non-drinker	633	47.6	526	52.4	
Moderate	733	37.3	883	62.7	
Heavy	695	55.8	399	44.2	

Note: Based on 4,845 adults, age 20 years and above, who had no missing data on food security and dental care need.

Wt.: weighted

Missing values for income, body mass index, and alcohol use were not reported in the table.

**Table IV. Unmet Dental Care Needs:  
Logistic Regression National Health and Nutrition Examination Survey, 2011-2012**

	AOR	95% CI	Significance
<b>Household Food Security</b>			
<b>Full</b>			
Marginal		[0.80,1.39]	
Low		[1.18,2.12]	**
<b>Predisposing Factors</b>			
<b>Gender</b>			
Female	0.57	[0.46,0.72]	***
<b>Male</b>	reference		
<b>Race/Ethnicity</b>			
<b>Non-Hispanic White</b>	reference		
Non-Hispanic Black		[1.84,3.00]	***
Mexican American		[1.18,2.95]	**
Other Hispanic		[0.94,2.20]	
Non-Hispanic Asian		[1.68,3.11]	***
Other races		[0.68,1.33]	
<b>Age in years</b>			
<b>20-34</b>	reference		
35-49		[1.68,2.72]	***
50-64		[2.14,3.99]	***
65 and above		[1.42,3.52]	***
<b>Education Level</b>			
Less than high school		[1.30,3.00]	**
High school graduate		[1.28,2.49]	***
Some college		[1.19,1.93]	***
<b>College graduate and above</b>	reference		

Note: Based on 4,845 adults, age 20 years and above, with no missing data on food security and dental care need.

AOR: adjusted odds ratio

Asterisks represent significant group differences by Unmet Dental Care Need Based on Logistic Regression.

\*\*\*P <0.001; \*\* .001 < P <0.01; \*0.01 < P <.05

	AOR	95% CI	Significance
<b>Enabling Factors</b>			
<b>Family Federal Poverty Level</b>			
0 to less than 1.25	1.67	[1.19,2.34]	**
1.25 to less than 2.00	1.55	[1.08,2.22]	*
2.00 to less than 4.00	1.17	[0.84,1.64]	
<b>4.00 and above</b>	reference		
<b>Marital Status</b>			
Married	reference		
Widowed/separated/ divorced/never	1.08	[0.82,1.43]	
<b>Insurance</b>			
Insured	0.63	[0.52,0.77]	***
<b>Uninsured</b>	reference		
<b>Last Dental Visit</b>			
<b>6 months to less than 1 year</b>	reference		
1 to less than 2 years	1.92	[1.44,2.55]	***
2 years and above	1.91	[1.38,2.66]	***
<b>Personal Health Practices</b>			
<b>Body Mass Index</b>			
<b>Less than 2</b>	reference		
25 to less than 30	1.23	[1.06,1.42]	**
30 and above	1.48	[1.19,1.85]	***
<b>Smoking Status</b>			
Current Smoker	1.99	[1.50,2.65]	***
Past Smoker	1.09	[0.85,1.41]	
<b>Never Smoke</b>	reference		
<b>Alcohol Drinking</b>			
Non-drinker	0.90	[0.76,1.08]	
Moderate	1.12	[0.90,1.40]	
<b>Heavy</b>	reference		

children with low or very low food security,<sup>11, 15</sup> and a study with school lunch programs in Brazil.<sup>17</sup>

### ***Addressing low food security***

Low food security is a consideration in the larger social context of food justice which includes issues such as local food movements, toxin-free foods, public investment/community development to regain supermarkets/large grocery stores, and labor laws, among other issues.<sup>15</sup> Efforts are being made to address individual and community needs for safe, healthful, and adequate food sources and have been supported by the U.S. Department of Agriculture (USDA).<sup>15</sup> Food deserts have been the primary foci of these efforts. When communities lose or do not have access to supermarkets or large grocery stores, non-traditional food retailers (i.e. gas-marts, pharmacies, dollar stores, small grocery stores) may fill the void; but often those retailers do not stock fresh fruits and vegetables.<sup>18</sup> Such markets with limited food choices often stock heavily processed, sugary foods and beverages.<sup>19</sup>

The USDA supports a variety of healthful feeding programs: the National School Lunch Program fed more than 20 million free lunches per school day to children in 2017;<sup>20</sup> and the Women Infants and Children (WIC) program had 7.3 million participants in 2017.<sup>21</sup> Additional programs from the USDA include the Supplemental Nutrition Assistance Programs (SNAP), School Breakfast Program, Fresh Fruit and Vegetable Program; Summer Food Service Program, Commodity Supplemental Food Program, Food Distribution Program on Indian Reservations, the Emergency Food Assistance Program, Special Milk Program, Farmers' Market Nutrition Program, and the Senior Farmers' Market Nutrition Program.<sup>22</sup> However, many people with low food security do not have access to the programs, are ineligible, or do not know about them. This lack of utility of the available food supplementation programs is a concern for general health; and, as indicated by our study results, is also a concern for unmet dental needs.

### ***Low food security and health needs***

This study indicates a link between unmet dental needs and low food security with adults having low food security being 58% more likely to have an unmet dental need (AOR=1.58, 95%CI=1.18, 2.12;  $p<.01$ ). Relationships between low food security and other health needs including unmet dental care need, require better understanding. Low food security is experienced differently for household of adults with children.<sup>3</sup> Children are found to experience less food insecurity than their mothers in the same household;<sup>3</sup> the child's needs are placed before the needs of the parent. Low-nutrient, high-calorie,

and highly processed foods are often low-cost and readily available; and food prices strongly influence food purchases.<sup>23</sup> Individuals with food insecurity often have diets which are pro-inflammatory, and cariogenic. However, Chi et al. found that although lower socioeconomic status was associated with food insecurity, the food insecurity was not associated with fast-food consumption. This had previously been postulated as a potential mechanism of linking food insecurity to caries considering that fast-foods are sources of added sugars, such as sugar-sweetened beverages.<sup>24</sup> The relationship between caries and diet is complex, and there are contradictory theories regarding what constitutes a healthful diet.<sup>25</sup> Some researchers have theorized that excessive carbohydrate intake, in the absence of preventive interventions, leads to dental disease followed by systemic disease.<sup>25</sup> Conversely, others view lipids as a leading factor for systemic disease and promote high carbohydrate diets which can be misinterpreted as a recommendation for a diet consisting of highly refined carbohydrates.<sup>25</sup>

Social and cultural norms associated with foods influence food choices, preferences, beliefs, and behaviors<sup>23</sup> adding to the complexity of food insecurity and influence on general as well as oral health. Food insecurity has been associated with increased rates of depression, diabetes, distress, and low medication adherence among adults with diabetes and an increased risk of opportunistic infections.<sup>26, 27</sup> Low food security has also been linked to increased incidence of hospitalizations among adults with HIV/AIDS.<sup>28</sup> Food insecurity has been associated with nutrition-related conditions such as higher rates of parental overweight/obesity, fewer healthful mealtime foods, barriers to fruit and vegetable access, and increased binge eating.<sup>29</sup>

Unmet dental care need is an additional burden as well as a challenge for individuals with food insecurity. While there are a number of USDA programs addressing issues related to food insecurity, there is a need to examine the additional deficiencies contributing to the amount of unmet dental need for adults in the U.S.

Limitations of this study include the epidemiological cross-sectional research design which did not include temporality and therefore does not include causation. For the purposes of this study, the association between food insecurity and unmet dental need is presented as a relationship. While a number of factors were controlled in the adjusted analyses, there may have been confounders that were not available in the data set. The sample population may have had unmet dental need due to the distribution and availability of dental providers. Dietary patterns were not included in the sample population which would be helpful in identifying the mechanisms between the

association of food insecurity and unmet dental care need. However, the study's strength comes from the nationally representative, highly regarded NHANES research. Dental examinations were completed by calibrated licensed dentists and the questionnaires were administered by extensively trained and calibrated researchers. While a larger sample size would have strengthened this study, multiple cycles of the NHANES did not include the same variables.

## Conclusion

Food insecurity and health disparities present serious challenges to policy makers in the U.S.<sup>5</sup> This study demonstrates a relationship between unmet dental care need and food insecurity. Dental professionals routinely query patients about their food intake due to its impact on oral and overall health, in addition to participating in community educational programs. Oral health care professionals should be aware of the various community food resource options available to individuals with low food security, make referrals to social service providers, and facilitate dental care for people with low food security through supportive policies to improve access to care.

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