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Association of Food Insecurity with Early Childhood Caries

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Abstract

Objectives

The aim of this study was to examine the association of food insecurity on the prevalence of dental caries in preschool children.

Methods

Eighty-two children, aged 12-71 months old, from the Marquette University School of Dentistry Community South Clinic and their caregivers participated in this cross-sectional study. Following informed consent, parents completed the validated six-item US Department of Agriculture food insecurity questionnaire and questions regarding demographic information and family structure. Upon clinical examination caries was recorded using the decayed, missing, filled teeth (dmft) index based on the International Caries Detection and Assessment System criteria.

Results

The correlation between dmft and food insecurity was found statistically significant ($P = 0.002$, $R^2 = 0.115$), and children of higher food insecurity demonstrated higher levels of dental caries. Food insecurity was also positively correlated with parental age ($P = 0.034$), whereby higher levels of food insecurity were associated with the father being less than 25 years of age. Results from the questionnaire revealed that 58.5 percent of the families were fully secure, 11.0 percent had marginal, 24.4 percent had low, and 6.1 percent had very low food security. Results from clinical examination reported dmft 4.09 ± 4.38 , dt 2.20 ± 2.83 , and ft 1.83 ± 2.95 . Most of the children (79.7 percent) were Hispanic, 53.1 percent were female and the median age of the sample was 48 months.

Conclusions

Results of the present study suggest that preschool children with food insecurity have higher levels of dental caries.

Introduction

Dental caries is the most prevalent chronic disease among children and adolescents **1**. Socioeconomic status has been strongly related to dental caries prevalence **1**, especially in children. In addition, socioeconomic status has been inversely related to food insecurity **2, 3**, and in turn, to dietary habits **4, 5**. Food insecurity is 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” **6**. A strong relationship between unhealthy dietary habits and dental caries **7** makes food insecurity a potential risk factor for caries.

Food insecurity has multiple characteristics as a concept and affects different levels in our society. One aspect is related to the quantity of food that someone has, based on his income, occupation and his ability to buy or produce enough food **8**. Another aspect of food insecurity is access to food that is safe to consume **8**. Across the US there are “food deserts” where people have difficulty to find affordable and good-quality food. Finally, food insecurity is related to nutritionally adequate food, meaning food that provides all the necessary nutrients for someone's health and development **8**. All these different aspects can be experienced at the individual, community or society level **8**. In the US around 12.3 percent of the households were food insecure in 2016 **9**. More specifically, 10.7 percent of the households in Wisconsin had low or very low food security with higher percentages located in the big cities such as Madison and Milwaukee **9**. An association between food insecurity with dental caries **10-12** and oral health disparities **13** has been reported in a limited number of studies. The correlation between food insecurity and dental caries may be attributed to the dietary behaviors of these families. For example, diets may be high in readily fermentable carbohydrates, as this may be what they can

afford with limited funds in order to provide the children with the necessary energy **5, 8**. In addition, lack of money may make it difficult for families to purchase dental hygiene supplies or afford regular periodic preventive dental care **14**. Finally, another reason for this association could be that food insecurity may be related with low educational levels, which in turn contributes toward lower oral health literacy **15**.

Early childhood caries (ECC) is defined as “the presence of 1 or more decayed (cavitated or non cavitated), missing, or filled tooth surfaces in any primary tooth in a child 71 months of age or younger,” and is considered an important public health problem **16**. ECC is associated with an increased risk for dental caries in the permanent dentition, loss of dental function, time lost from school, increased utilization of emergency room visits, need for treatment under general anesthesia, increased treatment costs, and diminished quality of life **16**. ECC has unique characteristics both from a clinical and etiologic perspective. More specifically, ECC has been strongly correlated with low socioeconomic level, high maternal oral health bacteria levels and feeding practices such as nocturnal feeding via bottles containing cariogenic fluids such as milk, infant formula, or juice **16**. Preschool children are entirely dependent on their family for caregiving and food selection, and ECC's etiology underscores this dependency **16**. Therefore, one may hypothesize that food insecurity might be associated with dental caries to an even greater degree than that among school-age children. However, to the best of the author's knowledge, no studies have evaluated this association in preschool-age children.

The aim of this study was to examine the association of food insecurity on the prevalence of dental caries in preschool children.

Methods

This was a cross-sectional study assessing the association between food insecurity and ECC. The study was approved by the Institutional Review Board of Marquette University (HR-3171) and the Institutional Review Board of A.T. Still University (ATSU).

Inclusion criteria for sample recruitment were children: a) 12-71 months old, b) with no chronic illnesses and taking no medication, and c) patients of record at the dental clinics of Marquette University School of Dentistry. Families that did not complete the questionnaire or children who came to the clinic with an adult not representing the household were excluded from the analysis. Power calculation determined that a minimum of 80 children was needed to achieve 80 percent power with $\alpha = 0.05$ and with a medium effect size.

Data collection was performed at the Marquette University School of Dentistry Community South Clinic from January through March 2016. Families with patients aged 12-71 months old were invited to participate in the study. The primary investigator of the study verbally informed the families in the waiting room for their option to participate in the study. To avoid selection bias, all families that fulfilled the inclusion criteria were asked to participate without any restriction. Following the informed consent, parents or guardians who represent the household were asked to complete the questionnaire and child's oral clinical examination followed.

Data regarding food insecurity were collected using the English and Spanish version of the six-item US Department of Agriculture (USDA) questionnaire to assess this construct **17**. Questionnaire responses were calculated using the USDA scoring protocol published for this questionnaire and provided a food insecurity score for the family. Based upon their total score, families were classified into one of the following categories: high food security (Score 0), marginal food security (Score 1), low food security (Score 2-4), and very low food security (Score 5,6). In addition, questions regarding parental educational level, age, employment status, family structure, and ways to overcome these issues were added to the questionnaire to allow a more comprehensive understanding of the families' profile (Appendix).

All children underwent a comprehensive dental examination at the clinic. During the exam, a mirror, a periodontal probe (WHO-621), and artificial light were utilized, and performed in line with standard infection control protocol. Dental caries were recorded calculating the decayed, missing, filled teeth (dmft) index based on the International Caries Detection and Assessment System (ICDAS) criteria. This method of classification enabled the inclusion of early stage lesions at the pre-cavitation stage and the calculation of d1mft index. Two pediatric dentists performed the clinical examinations. For examiners' calibration, both dentists conducted an examiner training and calibration comparing the examiners' recording on ten patients prior to the initiation of the study. Inter-examiner and intra-examiner reliability was assessed using Cohen's Kappa statistics and was $\kappa = 0.93$ for inter-examiner agreement and $\kappa = 0.98$ for intra-examiner agreement.

The primary outcome measured for this study was the association between food insecurity and ECC. Secondary outcomes were the association of food insecurity prevalence with demographic variables and family structure.

Data were analyzed using SPSS (SPSS, Chicago, Ill; version 20.0). Frequency, mean, and standard deviation (SD) were calculated for descriptive statistics. Chi-square test was used to investigate associations of demographic factors, family structure, educational level with food insecurity and multiple logistic regression model was used to detect correlations between food insecurity and ECC. Statistically significant differences were investigated at the level of $P < 0.05$.

Results

A total 102 child-caregiver pairs were invited to participate. Of them 82 child-caregiver pairs were included in this study and the response rate was 80.3 percent.

Analysis of demographic data of the children who participated in the study showed that the median age was 48 months, 47.6 percent were male and 52.4 percent were female. The majority of the children were Hispanic (79.3 percent), 12.2 percent were African-American, 6.1 percent were Caucasian, and 2.4 percent were Asian. Detailed information on children's demographics is presented in Table 1.

Table 1. Demographic Data of the Children

	<i>N</i>	%
Gender		
Male	39	47.6

Female	43	52.4
Age		
12 months old	2	2.4
24 months old	3	3.7
36 months old	12	14.6
48 months old	31	37.8
71 months old	34	41.5
Race		
Hispanic	65	79.3
African-American	10	12.2
Caucasian	5	6.1
Asian	2	2.4
Total	82	100

In regards to parental education, the majority of the mothers had college education (35.1 percent) whereas most fathers had high school (29.2 percent) or college education (27.8 percent) (Table 2). Most mothers were between 25 and 34 years old whereas the majority of the fathers were distributed between 25-34 years old and 35-44 years old. Finally, the majority of the fathers were employed (80.3 percent) and most mothers were not working (59.4 percent). Parental age and employment status are presented in further detail in Table 2.

Table 2. Parental Educational Level, Age, and Employment Status

		Father	Mother
Parental education	Primary school	16.7% (<i>n</i> = 12)	16.2% (<i>n</i> = 12)
	Middle school	20.8% (<i>n</i> = 15)	23.0% (<i>n</i> = 17)
	High school	29.2% (<i>n</i> = 21)	25.7% (<i>n</i> = 19)
	College	27.8% (<i>n</i> = 20)	35.1% (<i>n</i> = 26)
Parental age	18-24 years old	2.7% (<i>n</i> = 2)	1.3% (<i>n</i> = 1)
	25-34 years old	49.3% (<i>n</i> = 36)	46.6% (<i>n</i> = 46)
	35-44 years old	42.5% (<i>n</i> = 31)	35.9% (<i>n</i> = 28)
	45-54 years old	5.5% (<i>n</i> = 4)	3.8% (<i>n</i> = 3)
Parental employment status	Employed for wages	80.3% (<i>n</i> = 53)	34.8% (<i>n</i> = 24)
	Unemployed	13.6% (<i>n</i> = 9)	59.4% (<i>n</i> = 41)
	Self-employed	3.0% (<i>n</i> = 2)	1.4% (<i>n</i> = 1)
	Student	3.0% (<i>n</i> = 2)	4.3% (<i>n</i> = 3)

Results from the questionnaire revealed that 58.5 percent of the families had high, 11.0 percent had marginal, 24.4 percent had low, and 6.1 percent had very low food security. In further detail, 30.5 percent responded that “in the last year often the food they bought for their household didn't last, and didn't have money to get more.” Also, 35.4 percent answered that they “often couldn't afford to eat balanced meals in the last 12 months.” Eleven percent reported that “they had to cut the size of their meals or skip meals because there wasn't enough money for food in the last year” and that “in the last year were hungry but didn't eat because there wasn't enough money for food.” Finally, 9.8 percent of

the families stated that “they had to eat less than they wanted in the last year because there wasn't enough money for food.”

Regarding the family structure, the majority of the families (74.7 percent) reported that four to six people lived in their house, 16.5 percent reported that more than six people lived in their house, and 8.9 percent had three or less people living in their house. Regarding the number of children living at home, 61.5 percent had three to four children, 24.4 percent had one to two children, and 14.4 percent had five or more children living at home. In half of the families (46.8 percent) one or less people were providing in the household, and the other half (46.8 percent) had two people providing in their house income.

The clinical examination revealed that 56 percent had untreated decay. In further detail mean dmft was 4.09 ± 4.38 , d1mft was 4.82 ± 4.38 , dt was 2.20 ± 2.83 , d1t was 2.93 ± 3.01 , ft was 1.83 ± 2.95 , and mt was 0.06 ± 0.33 . Stratified dental caries indices data by food insecurity score is presented in Table 3.

Table 3. Stratified Dental Caries Indices Data by Food Insecurity Score

		dmft	dt	d1mft	d1t	ft	mt
Food security score	0 (n = 48)	2.94 ±	1.83 ±	3.77 ±	2.67 ±	1.02 ±	0.08 ±
		4.12	2.72	4.25	3.06	2.12	0.40
	1 (n = 9)	7.00 ±	1.56 ±	7.22 ±	1.78 ±	5.33 ±	0.11 ±
		5.66	1.74	5.52	1.72	5.03	0.33
	2 (n = 13)	5.00 ±	2.31 ±	5.85 ±	3.15 ±	2.69 ±	–
		3.76	2.81	3.95	2.91	2.98	
	3 (n = 3)	5.33 ±	3.67 ±	5.33 ±	3.67 ±	1.67 ±	–
		4.73	4.73	4.73	4.73	2.89	
	4 (n = 4)	6.50 ±	5.50 ±	6.75 ±	5.75 ±	1.00 ±	–
		2.89	2.65	3.30	3.10	1.41	
	5 (n = 3)	6.67 ±	4.33 ±	8.33 ±	6.00 ±	2.33 ±	–
		5.13	4.51	2.52	2.65	1.53	
	6 (n = 2)	–	–	2.50 ±	1.50 ±	–	–
				0.71	0.71		

Correlation between dmft and food insecurity was found statistically significant ($P = 0.002$, $R^2 = 0.115$) (Figure 1). Higher food insecurity was associated with higher dental caries (Table 3). This finding was evident especially in regards to the number of decayed teeth (dt, d1t) where mixed findings were seen in the number of filled teeth (ft). Food insecurity was also significantly correlated with parental age ($P = 0.034$). Children who had a father aged less than 25 years had higher food insecurity. Food insecurity was not significantly correlated with other demographic factors, family structure, and educational level.

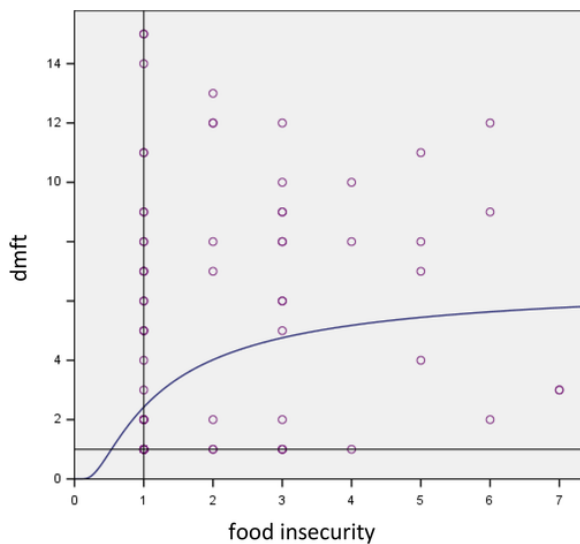


Figure 1 Multiple logistic regression model testing the association between food insecurity and early childhood caries.

Discussion

Results of this study suggest that preschool children from higher food insecurity families have higher dental caries. Also, father's age plays an important role in food insecurity, while other demographic factors and family structure were not found to significantly affect family's food insecurity.

The sample was collected in a university based community clinic and thus was not representative of the population. Approximately 80 percent of the patients are of Hispanic origin and 90 percent have Medicaid dental insurance. Around 10 percent of the clinic's population are cash payment patients.

The ICDAS criteria were chosen to record the carious lesions. This classification method includes the detection of caries at the pre-cavitation stage **18**. A preschool child with white spot lesions was considered being at high caries risk even if there are no other cavitated lesions present **19**. Since the sample for this study was comprised of children younger than 71 months it was important to record early stage carious lesions in order to detect high caries risk children. Based on the ICDAS criteria the dmft index was calculated for each subject. The previous US study that tested the association of dental caries with food insecurity in schoolchildren used the US National Health and Nutrition Examination Survey data that record the presence or absence of untreated decay **10**. The dmft index gives more detailed data with regard to caries history and for this reason it was utilized in our analysis.

The USDA six-item survey was used to calculate food insecurity in our study. This was a validated questionnaire available in both English and Spanish versions and has been used in studies looking at the relationship between food insecurity and caries in children **10, 12, 13**. Additionally, as it has been previously used in similar studies, it enabled us to more effectively compare our results with previous studies. A 18-item survey is also available through USDA but the 6-item was chosen to maximize the response rate.

Food insecurity levels found in this study were similar to what was reported by Chi et al. in their analysis of data from the US National Health and Nutrition Examination Survey and the study of Chi et

al. conducted in Seattle, WA **10, 13**. Thus, food insecurity within the limitation of the sample of the present study does not seem to differ significantly between the families of preschool and school-age children. The majority of the families in this study had three to four children. Thus it is possible that many of the siblings of the preschool children who participated in this study were of school age and had similar food insecurity as the one reported in the past **10**. In comparison to the study by Frazao et al., food insecurity levels were lower in the present study **12**. However, this deviation can be attributed to the differences between the two countries where the studies were conducted.

With regard to the clinical data, the sample in the present study had higher levels of dental caries compared to the national mean for 5-year-old children **20**. This finding may be related to the fact that the sample in the present study was drawn from a dental clinic which people may visit seeking dental treatment when a dental problem is already apparent. In other words, children with lower caries levels may not be seen at this young age at the dental clinic as many parents seek dental care for their children only when a problem occurs. Also, this study used the dmft index to detect dental caries which has higher specificity to the tool used in the US National Health and Nutrition Examination Survey that detected only the presence of untreated decay **18**.

The results of this study were similar to studies of schoolchildren that found those who are from higher food insecurity families to present higher caries rates **10, 12**. The correlation between food insecurity and dental caries may be attributed to the dietary behaviors of these families that may include diets high in easily fermentable carbohydrates in order to provide the children with the necessary energy **8**. Also, food insecurity may restrict people's food choices leading to purchasing unhealthy and highly cariogenic foods that are lower in cost and nonperishable. Another explanation could be related to the association of food insecurity with poverty and its consequences. In other words, food insecurity might be a manifestation of a larger picture of poverty that forces people to make decisions under the stress of limited resources. Hence, when faced with numerous competing demands, these families may not prioritize purchase of dental hygiene supplies or regular periodic preventive dental care **14**. No information regarding dietary habits and access to dental hygiene supplies was collected in this study. In the future, collection of this information may help to determine the specific behavioral factors that correlate food insecurity to dental caries. Also, another reason for this association could be that food insecurity may be related with low educational level which in turn contributes toward lower oral health literacy **15**. Finally, food insecure families may live in low-income areas that can be a food desert with limited dietary choices. Another finding of the present study was the association of father's age with food insecurity. It was found that when the father of the family was younger than 25 years old, there seems to be higher food insecurity in the family. This finding may be related to the maturity and financial stability of the father as he gets older and thus is better able to provide for his family.

A limitation of the study was the study sample was from a dental setting and with a higher predilection for Hispanics. Also, this was a cross-sectional study and did not test the duration a family may have been in food insecurity. Additionally, some families denied completing the questionnaire after reviewing the informed consent document. Thus, it was possible that some families experiencing higher levels of food insecurity may have been embarrassed to report food insecurity issues and thus did not participate in the study. In the future, it will be important to conduct a national study related to food insecurity and dental caries in preschool children. Furthermore, the findings of this study showed

that it is important to advocate for policies that will improve food quality in highly insecure families. For example, food stamps should allow people to buy nutritious, high quality foods and avoid foods such as sweetened soft-drinks that contribute to obesity and caries.

Conclusions

This is the first study testing the effect of food insecurity on dental caries in preschool children. Food insecurity is a factor associated with dental caries in preschool children, and public health efforts should focus on policies to eliminate food insecurity of low-income households and to make quality food more accessible and affordable.

Conflict of interest

The study did not receive any funding and all authors declare no financial and personal relationships with other people or organizations that could bias their work.

APPENDIX: Questionnaire

Circle the ONE answer that represents you more

Father's educational level: _____

a = Primary, b = Middle, c = High, d = College, e = Don't know

Father's employment status: _____

a = employed for wages, b = self-employed, c = unemployed

d = student, e = military, f = retired, g = Don't know

Father's age: _____

a = 12–17, b = 18–24, c = 25–34, d = 35–44, e = 45–54, f = 55–64, g = over 65 years old

1. How often the food that you bought for your household didn't last, and you didn't have money to get more in the 12 months?
 - a. Often true
 - b. Sometimes true
 - c. Never true
 - d. Don't know
2. How often you couldn't afford to eat balanced meals in the last 12 months?
 - a. Often true
 - b. Sometimes true
 - c. Never true
 - d. Don't know
3. In the last 12 months, did you ever cut the size of your meals or skip meals because there wasn't enough money for food?
 - a. Yes
 - b. No (skip question 4)
 - c. Don't know (skip question 4)
4. If yes, how often did this happen?
 - a. Almost every month
 - b. Some months but not every month

- c. Only 1 or 2 months
 - d. Don't know
5. In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money for food?
- a. Yes
 - b. No
 - c. Don't know
6. In the last 12 months, were you ever hungry but you didn't eat because there wasn't enough money for food?
- a. Yes
 - b. No
 - c. Don't know

Mother's educational level: _____

1 = Primary, 2 = Middle, 3 = High, 4 = College

Mother's employment status: _____

a = employed for wages, b = self-employed, c = unemployed

d = student, e = military, f = retired, g = Don't know

Mother's age: _____

a = 12–17, b = 18–24, c = 25–34, d = 35–44,

e = 45–54, f = 55–64, g = over 65 years old

7. How many people live in your house?
- a. 3 or less
 - b. 4 to 6
 - c. More than 6
8. How many children live in your house?
- a. 1 to 2
 - b. 3 to 4
 - c. More than 5
9. How many people provide in your household?
- a. 1 or less
 - b. 2
 - c. 3 to 5
 - d. More than 5
10. What is your child's race?
- a. Hispanic
 - b. African-American
 - c. Asian
 - d. Caucasian
 - e. Other

11. How do you meet your food needs?

12. Can you manage without assistance from the State?

- a. Yes
- b. No

If not, what coping strategies should the State suggest to support you?

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