

Assessing the relationship between children's oral health status and that of their mothers

Bruce A. Dye, DDS, MPH; Clemencia M. Vargas, DDS, PhD; Jessica J. Lee, DDS; Laurence Magder, PhD, MPH; Norman Tinanoff, DDS, MS

Early childhood caries (ECC) in the United States continues to affect a significant number of children. Almost one-quarter (23.7 percent) of children between the ages of 2 and 5 years has had caries, and 18.7 percent of children have untreated caries.¹ ECC is associated with caries in permanent teeth² and dental pain,³ as well as eating difficulties, disrupted sleep and affected play activity.⁴ Although progress has been made in understanding the etiology of caries and the measures that can be taken to prevent it, ECC is increasing among traditionally low-risk groups.⁵ Furthermore, the prevalence of ECC is greatest among the most disadvantaged groups in society—specifically, racial or ethnic minorities and the poor.^{1,6-8} However, children from these backgrounds are the ones least likely to receive dental care.⁹

A person's oral health status can be measured in a number of ways, ranging from the presence or absence of oral disease to more subjective measures involving evaluation of the quality of oral health. There are several well-supported pathways through which a mother's oral health status and its determinants are of direct influence on her child's oral health. One such pathway is the vertical transmission

ABSTRACT

Background. The authors conducted a study to describe the relationship between the oral health of young children and that of their mothers.

Methods. Using data from the Third National Health and Nutrition Examination Survey and a related birth certificate-linked file, the authors compiled a sample of 1,184 mother/child pairs for children aged 2 through 6 years. The authors performed logistic and cumulative logistic regression analyses by using children's caries experience and untreated caries status as dependent variables. They evaluated the mothers' untreated caries status and tooth loss status along with other covariates, including age, race/ethnicity and poverty status.

Results. Children of mothers who had high levels of untreated caries were more than three times as likely (odds ratio [OR], 3.5; 95 percent confidence interval [CI], 2.0-6.2) to have higher levels of caries experience (treated or untreated dental caries) compared with children whose mothers had no untreated caries. A similar relationship was observed between mothers' tooth loss and caries experience among their children. The children of mothers with high levels of tooth loss were more than three times as likely (OR, 3.3; 95 percent CI, 1.8-6.4) to have higher levels of caries experience compared with children of mothers with no tooth loss; for mothers with moderate tooth loss, the OR was 2.3 (95 percent CI, 1.5-3.5).

Conclusions. Mothers' oral health status is a strong predictor of the oral health status of their children.

Practice Implications. Preventive plans for children should be based on a caries risk assessment. The results of this study demonstrate that basic information obtained from the child's mother regarding her oral health status is valuable in helping the dentist determine the child's caries risk.

Key Words. Third National Health and Nutrition Examination Survey; oral health; pediatric dentistry; caries risk; epidemiology. *JADA 2011;142(2):173-183.*



Dr. Dye is a dental epidemiology officer, National Center for Health Statistics, Hyattsville, Md., Centers for Disease Control and Prevention, and an adjunct faculty member, Department of Health Promotion and Policy, Dental School, University of Maryland, Baltimore. Address reprint requests to Dr. Dye at National Center for Health Statistics, 3311 Toledo Road, Room 4416, Hyattsville, Md. 20782, e-mail "bfd1@cdc.gov".

Dr. Vargas is an associate professor, Department of Health Promotion and Policy, Dental School, University of Maryland, Baltimore.

At the time this study was conducted, Dr. Lee was a student, Dental School, University of Maryland, Baltimore. She now is in the Bronx-Lebanon Pediatric Dentistry Residency program, New York City.

Dr. Magder is a professor, Department of Epidemiology and Public Health, School of Medicine, University of Maryland, Baltimore.

Dr. Tinanoff is a professor and the chair, Department of Health Promotion and Policy, Dental School, University of Maryland, Baltimore.

of caries, which occurs when a mother passes mutans streptococci (MS) to her child.¹⁰⁻¹³

The results of previous studies also have supported a correlation between the mother's attitude toward oral health and dental care and the level of oral health and degree of dental care utilization by the child. High dental care-related anxiety or fear in the mother was associated with higher levels of caries and fewer dental visits for the child,¹⁴ and children whose parents had visited a dentist in the preceding year were more likely to have had a visit themselves.^{15,16} Furthermore, mothers who were satisfied with their own oral health status were more likely to take their children to the dentist^{14,17}; for low-income minority children, dental care utilization was higher when their mothers had a regular source of dental care.¹⁸

Researchers also have found that mothers' behaviors are correlated with children's oral health. The toothbrushing habits of the mother are associated directly with those of her child,^{19,20} and mothers heavily influence their children's dietary habits and food choices. Children's dietary habits vary according to their mothers' educational level,²¹ resulting in low-income families' consuming diets higher in added sugars than diets of higher-income families.²² Evidence suggests that daily sugar consumption is an independent risk factor for ECC and that supervised toothbrushing with a fluoridated dentifrice is a proven intervention to reduce ECC.^{23,24}

Dental caries generally is considered a key outcome for assessing the oral health status of children; for adults, dental caries and tooth loss are considered important measures of clinical oral health status. More importantly, for both children and adults, the prevalence of untreated caries is used frequently as a sentinel measure regarding issues related to access to dental care. Although dental care professionals intuitively accept the correlation between the oral health status of mothers and that of their children, limited information exists to support this relationship. Furthermore, evidence in the literature is nearly nonexistent in the context of quantifying the expected association between poor oral health of mothers and that of their children.

Consequently, the aim of our study was to evaluate the relationship between the oral health status of mothers and that of their children by using data from a nationally representative sample of the U.S. population.

METHODS AND PARTICIPANTS

Data source. For this analysis, we used data from the Third National Health and Nutrition Examination Survey (NHANES III),²⁵ which was conducted by the National Center for Health Statistics (NCHS), Hyattsville, Md., Centers for Disease Control and Prevention (CDC), from 1988 through 1994. The NHANES III followed a stratified multistage sampling design to obtain a representative probability sample of the civilian noninstitutionalized population of the United States. Interviewers collected data for NHANES III via a personal interview at each participant's home and a health examination at a mobile examination center. The NHANES III oversampled non-Hispanic blacks, Mexican Americans, children younger than 6 years and people 60 years and older.

Interviewers collected oral health data from adults on behalf of children 2 years and older during the home interview, and licensed and calibrated dentists collected information through a detailed oral examination. The dentists conducted the examination by using a plane mirror, a no. 23 sickle-shaped explorer and artificial light. Before the examination, they dried the teeth with compressed air.

Additional information detailing the study design, examination protocols and informed consent procedures has been provided elsewhere.²⁶⁻²⁸

For these analyses, we used data from the NHANES III adult and youth files, the examination file and the linked natality file.²⁵ The key element for this analysis was pairing a mother with her child. Relationships between members of a household are not recorded in NHANES III, and not all mothers or all children living within the same household were sampled. However, households are identified according to a unique identification number. Our overall strategy for creating the mother/child pair was to match an adult woman with the oldest child younger than 7 years within a household. To avoid duplication

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Researchers have found that the toothbrushing habits of the mother are associated directly with those of her child.

ABBREVIATION KEY. **CDC:** Centers for Disease Control and Prevention. **dfs:** Decayed and filled surfaces (primary teeth). **ds:** Decayed surface (primary teeth). **ECC:** Early childhood caries. **FPT:** Federal poverty thresholds. **MS:** Mutans streptococci. **NCHS:** National Center for Health Statistics. **NHANES III:** Third National Health and Nutrition Examination Survey.

of the mother's records, we selected the oldest child from households in which multiple children resided.

We then used a series of algorithms to confirm a successful match by using maternal birth information from the NHANES III-linked natality file. By using the linked natality file to establish the mother/child relationship, we limited the definition of mothers to biological mothers. However, 94 percent of mothers living with children younger than 18 years lived with their biological children.²⁹ Of the 8,836 children 2 months through 6 years of age from whom health interview data were obtained in NHANES III, 7,779 had birth certificates from the NCHS Division of Vital Statistics linked to their NHANES III data record.

Matching process. Of the 10,649 women participating in NHANES III, 7,064 reported having had at least one live birth (Figure). We matched a total of 3,216 women and children aged 2 months through 6 years according to a unique household identification number; from this group, we selected 2,408 women whose age corresponded—within one year—to the mother's age on the child's birth certificate. Of these women, 2,273 had been identified (via coding) as the child's mother by the interviewer. We paired 1,070 of the women to a single child and 1,203 women to more than one child. From among the 1,203 nonunique pairings of mothers with more than one child, we selected the oldest child, resulting in 533 unique mother/child pairs. If a child was paired with more than one adult in the household ($n = 37$), we chose the pair that included the woman whose age was closest to that on the child's birth certificate; this yielded 18 mother/child pairs, which we added to the 1,566 unique mother/child pairs, resulting in a total of 1,584 pairings. We excluded pairs in which the mother or child had not undergone any part of the dental examination, which resulted in a total of 1,338 pairs.

The dental examination conducted in children younger than 2 years was a simplified

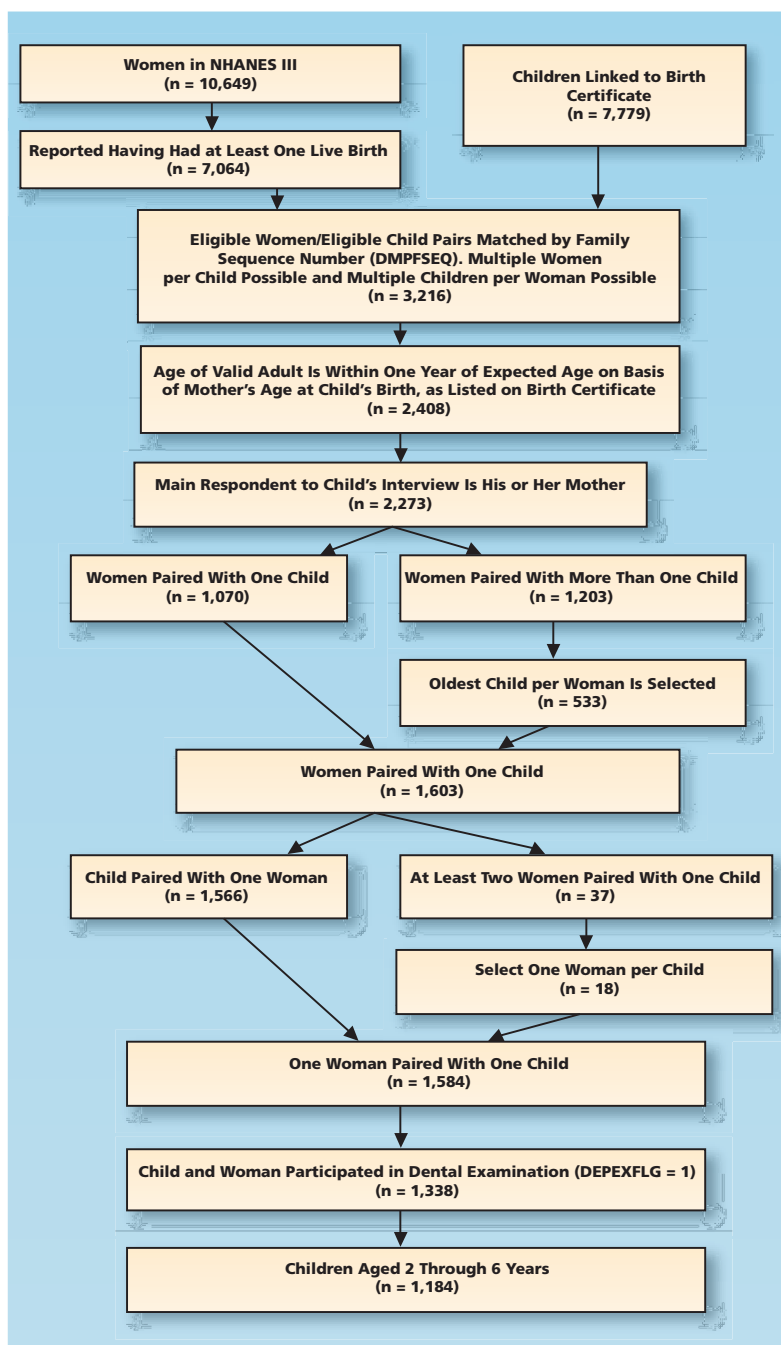


Figure. Matching algorithm for mother/child pairs. NHANES III: Third National Health and Nutrition Survey.

screening procedure and not a tooth-based comprehensive caries examination. Consequently, we excluded 154 children younger than 2 years, yielding an analytical sample composed of 1,184 pairs of mothers and their children.

Study population. For this study, we used data from 1,184 children aged 2 through 6 years obtained by selecting only one child per house-

hold (the oldest in this age range) who was matched to a mother in the same household and who, along with the mother, had participated in an oral health examination. We did not include all children aged 2 through 6 years from the same household in the analysis. Moreover, children may have been selected to participate in NHANES from households in which no woman had been selected for participation. Therefore, we could not match these children to a woman living in the same home. Children included in the study were somewhat older (mean [standard error] age, 4.5 [0.1] years) than children not included (mean [standard error] age, 3.8 [0] years); this can be explained by our selection of the oldest child in homes in which more than one child matched with the same mother. There were no differences between children included and not included in the analytical sample according to sex, race/ethnicity, caries prevalence or untreated caries.

Oral health variables. We assessed dental caries according to prevalence and severity for both mother and child. We used Healthy People 2010 objective 21-1³⁰ (that is, caries experience in children) and objective 21-2³⁰ (that is, untreated caries in children and mothers) as guidance. We classified a child as having had caries experience (prevalence) if he or she had at least one tooth affected by untreated caries at the time of the examination or had a dental restoration. This corresponded to a decayed and filled surfaces (dfs) score equal to or greater than 1 and reflects the accepted working definition of ECC.³¹ We classified a child as having untreated caries (prevalence) if he or she had at least one tooth with a decayed surface (ds) score equal to or greater than 1.

For both mothers and their children, we determined the extent of untreated caries by using “high,” “moderate” and “none” categories.³² High corresponds to six or more dental surfaces with caries; moderate equates to one through five dental surfaces with caries; and none corresponds to no dental surfaces with untreated caries. We used a similar approach to categorize the extent of caries experience in children. We classified the extent of missing teeth due to caries or periodontal disease in mothers as “none” if they had no missing teeth, “moderate” if they had one through four missing teeth and “high” if they had five or more missing teeth.

In this sample of children, only 201 (17 percent) had at least one permanent tooth and only 14 (1.2 percent) had any caries experience in permanent teeth. Consequently, we did not include children’s permanent teeth in our calculation of caries experience or untreated caries.

Sociodemographic variables. The sociodemographic characteristics for which we controlled in the multivariate analyses were age, race/ethnicity and poverty status. Ages of mothers and children were continuous variables measured in single years. We determined race/ethnicity on the basis of respondents’ self-reports; categories included were non-Hispanic white, non-Hispanic black, Mexican American and others. We defined poverty status according to the ratio of family income to the federal poverty thresholds³³ (FPT), adjusted for family size and composition. The FPT is a threshold of family income needed for a family to live above poverty.³⁴ We classified families living below 100 percent of the FPT as poor, families from 100 percent to less than 300 percent as near poor and families at 300 percent or above as nonpoor.

Statistical analysis. We conducted all analyses by using statistical software (SUDAAN, Version 9.0, Research Triangle Institute, Research Triangle Park, N.C.; SAS, version 9.1, SAS Institute, Cary, N.C.). To maximize the use of available data, we excluded participants for whom information was missing for specific covariates from the analyses that included those variables. We first conducted a descriptive analysis in which we examined the distribution of each key variable for the mother/child pairs. We then explored covariate relationships by using regression modeling. We fitted the final multivariable models by using all of the covariates evaluated in the bivariate analyses regardless of their significance level. We assessed for interactions between covariates and found none. When the dependent variable was dichotomous—for example, caries prevalence—we developed these models by using PROC LOGISTIC in SUDAAN. We developed cumulative (proportional odds) models when the dependent variable was multicategorical, such as dental caries severity, and we made these models by using PROC MULTLOG in SUDAAN.

Hosmer and Lemeshow³⁵ reported that proportional odds models are the most frequently used modeling technique for ordinal logistic regression

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The authors classified a child as having had caries experience if he or she had at least one tooth affected by untreated caries at the time of the examination or had a dental restoration.

TABLE 1

Children's caries status, according to demographic characteristics, United States, 1988-1994.*

VARIABLE	PERCENTAGE OF CHILDREN (STANDARD ERROR)					
	Caries Experience (Treated or Untreated Caries)			Untreated Caries		
	No caries experience	Moderate (1-5 surfaces)	High (6 or more surfaces)	No untreated caries	Moderate (1-5 surfaces)	High (6 or more surfaces)
Total	68.7 (2.7)	18.0 (1.9)	13.3 (1.6)	79.8 (1.9)	13.7 (1.7)	6.5 (0.9)
Child's Age in Years						
2	94.3 (1.8)†	—‡	—	94.7 (1.7)†	—	—
3	86.4 (2.7)	7.0 (1.9)	6.6 (1.7)	87.6 (2.6)	7.2 (2.1)	5.1 (1.5)
4	70.2 (4.4)	17.1 (3.9)	12.7 (2.7)	75.9 (4.0)	16.9 (3.6)	7.2 (1.7)
5	63.9 (3.7)	19.0 (3.8)	17.1 (4.3)	78.3 (4.7)	16.1 (3.9)	10.1 (3.0)
6	53.6 (5.2)	28.2 (3.7)	18.2 (3.1)	76.5 (3.1)	17.5 (2.9)	6.0 (1.5)
Race/Ethnicity						
Non-Hispanic white	72.1 (3.6)	17.9 (2.6)	10.0 (2.2)	84.5 (2.7)	12.1 (2.2)	3.4 (1.1)
Non-Hispanic black	63.6 (3.1)	22.3 (2.6)	14.1 (2.6)	73.9 (2.7)	18.4 (2.5)	7.7 (1.6)
Mexican American	54.3 (3.9)	20.2 (2.5)	25.5 (3.6)	62.4 (3.2)	21.3 (2.6)	16.3 (2.0)
FPT§						
Poor	64.4 (4.1)	16.6 (2.8)	19.1 (3.6)	72.5 (3.4)	17.0 (3.1)	10.5 (2.2)
Near poor	65.1 (3.2)	23.3 (2.7)	11.6 (2.3)	78.0 (2.9)	15.3 (2.2)	6.8 (1.4)
Nonpoor	81.3 (5.0)	11.0 (3.8)†	7.6 (2.5)	90.2 (3.1)	—	—

* Source: Third National Health and Nutrition Examination Survey.²⁵
† Estimate may be unreliable; relative standard error > 30 percent but < 40 percent.
‡ Estimate is unreliable; relative standard error ≥ 40 percent.
§ FPT: Federal poverty thresholds. Less than 100 percent of FPT is poor, 100 to 299 percent of FPT is near poor and ≥ 300 percent of FPT is nonpoor.

analyses. Moreover, Taylor and Becker³⁶ suggested that this approach can provide increased power, more precise estimates and a better fitted model when the dependent variable is ordinal or when it exhibits continuous qualities.³⁶ In brief, the odds ratio (OR) for a predictor in a proportional odds model is reflective of a cumulative or summary OR obtained from each of the possible dichotomous logistic regressions, and it can be interpreted as the odds of being lower or higher than the reference level across the entire ordinal scale of the dependent variable. Dye and colleagues³² used this statistical methodology to estimate the odds of a categorical increase in the number of surfaces affected by untreated caries. We tested interactions between mothers' oral health indicators and poverty and race/ethnicity and found them to be nonsignificant.

RESULTS

We included in this study a total of 1,184 children 2 through 6 years of age paired with their mothers. The mean age of the mothers was 31 years, and the mean age of their children was

4.5 years. Approximately two thirds of the participants (61.9 percent of the children and 62.3 percent of the mothers) identified themselves as non-Hispanic white, 18 percent as non-Hispanic black and 12 percent as Mexican American. We classified close to one-half (47.8 percent) of the pairs as near poor, slightly more than one-quarter (27.6 percent) as poor and one-quarter (24.6 percent) as nonpoor.

Children's caries status. Table 1 presents children's caries experience (dfs) and untreated caries (ds) according to sociodemographic characteristics. Overall, 31.3 percent of children had experienced caries and 20.2 percent had untreated caries. As children grew older, the prevalence of caries experience (dfs) and untreated caries (ds) generally increased as well. The prevalence of caries experience among children living in poverty was nearly twice as high as that among children living in nonpoor households (35.6 percent and 18.7 percent, respectively). Untreated caries prevalence among Mexican-American children was more than twice as high as that among non-Hispanic

TABLE 2

Mothers' untreated caries and missing teeth, according to race/ethnicity and poverty status, United States, 1988-1994.*

VARIABLE	PERCENTAGE OF MOTHERS (STANDARD ERROR)					
	Untreated Caries			Missing Teeth		
	None	Moderate (1-5 surfaces)	High (6 or more surfaces)	None	Moderate (1-4 teeth)	High (5 or more teeth)
Total	70.9 (2.5)	18.5 (1.7)	10.6 (1.7)	55.6 (1.8)	33.5 (1.8)	10.8 (1.4)
Race/Ethnicity						
Non-Hispanic white	77.1 (3.5)	13.1 (2.1)	9.8 (2.5)	62.3 (2.6)	29.2 (2.6)	8.5 (1.8)
Non-Hispanic black	51.7 (2.8)	31.2 (3.1)	17.1 (2.3)	35.8 (3.2)	41.5 (2.6)	22.7 (2.7)
Mexican American	64.3 (3.0)	27.3 (3.0)	8.4 (0.9)	53.9 (3.0)	39.3 (3.4)	6.8 (1.3)
FPT†						
Poor	48.4 (4.5)	35.4 (3.3)	16.2 (3.5)	44.6 (4.6)	41.4 (3.3)	14.0 (2.6)
Near poor	72.5 (3.1)	15.5 (2.4)	12.0 (2.3)	54.6 (3.9)	32.9 (3.4)	12.6 (2.4)
Nonpoor	—‡	—	—	71.6 (4.3)	26.4 (4.1)	—

* Source: Third National Health and Nutrition Examination Survey.²⁵
† FPT: Federal poverty thresholds. Less than 100 percent of FPT is poor, 100-299 percent of FPT is near poor and ≥ 300 percent of FPT is nonpoor.
‡ Estimate is unreliable: relative standard error ≥ 40 percent.

white children (37.6 percent and 15.5 percent, respectively).

Mothers' oral health status. Table 2 shows the oral health status of mothers, represented by untreated caries and missing teeth. Overall, 29.1 percent of mothers had untreated caries and 44.3 percent had lost at least one tooth as a result of dental disease. The prevalence of untreated caries in non-Hispanic black mothers was more than twice as high as that in non-Hispanic white mothers (48.3 percent and 22.9 percent, respectively). The prevalence of tooth loss in non-Hispanic black mothers was nearly twice as high as that in non-Hispanic white mothers (64.2 percent and 37.7 percent, respectively).

Unadjusted logistic models. Table 3 shows the relationship between a child's caries status and his or her mother's level of untreated caries. In logistic regression models not adjusted for potential confounders, children whose mothers had high levels of untreated caries (six or more affected coronal surfaces) were three times more likely to have had caries experience or untreated caries than were children whose mothers had no untreated caries. Children whose mothers had moderate levels of untreated caries (one to five affected surfaces) were more than twice as likely to have had caries experience or untreated caries compared with children whose mothers had no untreated caries. Children were more likely to have had caries experience or untreated caries if they were older, Mexican American, poor or near poor.

Adjusted logistic models. After adjusting for race/ethnicity, poverty status and the ages of mothers and children, we found that children of mothers with high levels of untreated caries remained at a significantly higher risk of having had caries experience or untreated caries compared with children whose mothers did not have high levels of untreated caries. Children of mothers with moderate levels of untreated caries also remained at a significantly higher risk of having had caries experience, but they were no longer at a significantly higher risk of having untreated caries. Furthermore, in both models, poverty status was no longer associated with a child's caries status.

Unadjusted cumulative models. Unadjusted results from cumulative logistic models indicated that higher levels of untreated caries in a mother were associated with higher levels of caries experience and untreated caries in her child. Children were more likely to have experienced higher levels of caries or to have had higher levels of untreated caries if they were older, Mexican American, poor or near poor (Table 3).

Adjusted cumulative models. In cumulative models in which we adjusted for race/ethnicity, poverty status and ages of mothers and children, the children of mothers with high levels of untreated caries were more likely to have experienced a higher prevalence of caries and higher levels of untreated caries than were other children. These models also showed that

TABLE 3

Association between child's caries status and severity of mother's untreated caries, United States, 1988-1994.*

VARIABLE	LOGISTIC REGRESSION MODELS†				CUMULATIVE LOGISTIC REGRESSION MODELS			
	Caries Experience (Yes/No)		Untreated Caries (Yes/No)		Increasing Caries Experience		Increasing Untreated Caries	
	Unadjusted OR‡ (95% CI§)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Mother's Untreated Caries								
High (≥ 6 surfaces)	3.1 (1.7-5.7)	2.9 (1.5-5.5)	3.2 (2.0-5.2)	2.3 (1.3-4.0)	3.5 (2.0-6.2)	3.4 (1.8-6.3)	3.4 (2.1-5.4)	2.3 (1.4-4.0)
Moderate (1-5 surfaces)	2.7 (1.6-4.6)	2.3 (1.3-3.9)	2.8 (1.5-5.2)	1.7 (1.0-3.1)	2.7 (1.6-4.5)	2.1 (1.3-3.6)	2.8 (1.5-5.2)	1.7 (1.0-2.9)
None	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Child's Age in Years	1.8 (1.5-2.0)	1.9 (1.7-2.2)	1.3 (1.2-1.5)	1.4 (1.2-1.6)	1.7 (1.5-1.9)	1.8 (1.6-2.1)	1.3 (1.2-1.5)	1.4 (1.2-1.6)
Mother's Age in Years	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (1.0-1.0)	1.0 (1.0-1.1)	1.0 (0.9-1.0)	1.0 (1.0-1.0)
Race/Ethnicity								
Mexican American	2.2 (1.3-3.5)	2.6 (1.6-4.4)	3.3 (2.0-5.5)	3.0 (1.8-5.2)	2.4 (1.4-3.9)	3.1 (1.8-5.2)	3.5 (2.1-5.6)	3.3 (1.9-5.6)
Non-Hispanic black	1.5 (1.0-2.3)	1.4 (0.9-2.3)	1.9 (1.2-3.2)	1.7 (0.9-3.0)	1.5 (1.0-2.2)	1.4 (0.8-2.4)	1.9 (1.2-3.2)	1.6 (0.9-2.9)
Non-Hispanic white	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
FPT¶								
Poor	2.4 (1.2-5.0)	1.8 (0.8-3.8)	3.5 (1.5-8.0)	1.6 (0.6-4.3)	2.5 (1.2-5.4)	1.1 (0.4-2.8)	3.6 (1.6-8.1)	1.7 (0.7-4.5)
Near poor	2.3 (1.3-4.3)	1.8 (0.8-3.8)	2.6 (1.2-5.4)	1.9 (0.8-4.3)	2.2 (1.2-4.0)	1.6 (0.8-3.3)	2.6 (1.3-5.4)	1.9 (0.8-4.4)
Nonpoor	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

* Source: Third National Health and Nutrition Examination Survey.²⁵
† Logistic regression requires the outcome variable to be two levels (yes or no).
‡ OR: Odds ratio.
§ CI: Confidence interval.
¶ FPT: Federal poverty thresholds. Less than 100 percent of FPT is poor, 100-299 percent of FPT is near poor and ≥ 300 percent of FPT is nonpoor.

after we adjusted for children's and mothers' ages, race/ethnicity and poverty status, children who were Mexican American were three times more likely to have higher levels of caries experience (OR, 3.1; 95 percent confidence interval [CI], 1.8-5.2) and untreated caries (OR, 3.3; 95 percent CI, 1.9-5.6) compared with non-Hispanic white children. Regarding poverty status, we observed the same pattern in the adjusted cumulative models that we observed in the adjusted logistic models.

Unadjusted logistic models. Table 4 presents the relationship between the extent of tooth loss in mothers and their children's caries status. In unadjusted logistic regression models, children whose mothers had high levels of tooth loss (five or more teeth) were at least three times more likely to have had caries experience or untreated caries than were children whose mothers did not have any tooth loss. The association remained when mothers had one to four missing teeth, but the magnitude of the association was lower.

Adjusted logistic models. After adjusting

for the ages of the mother and her child, race/ethnicity and poverty status, we found that any level of missing teeth remained significantly associated with a child's caries experience in a logistic model. Children were nearly three and one-half times more likely to have experienced caries if their mother had high levels of tooth loss and were twice as likely to have experienced caries if their mother had moderate tooth loss compared with children of mothers who had no tooth loss. Although children were about three and one-half times more likely to have untreated caries if their mother had high levels of tooth loss than if their mothers had no tooth loss, children whose mothers had moderate tooth loss were no more likely to have untreated caries than were children whose mothers had no tooth loss. Mexican-American children also were more likely to have experienced caries or to have untreated caries than were non-Hispanic white children.

Cumulative logistic models. Results from the cumulative logistic models also indicated that higher levels of maternal tooth loss were

TABLE 4

Association between child's caries status and mother's tooth loss, United States, 1988-1994.*

VARIABLE	LOGISTIC REGRESSION MODELS†				CUMULATIVE LOGISTIC REGRESSION MODELS			
	Caries Experience (Yes/No)		Untreated Caries (Yes/No)		Increasing Caries Experience		Increasing Untreated Caries	
	Unadjusted OR‡ (95% CI§)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Mother's Missing Teeth Severity								
High (≥ 5 teeth)	3.1 (1.6-5.9)	3.4 (1.5-8.2)	3.5 (2.0-6.2)	3.5 (1.6-7.9)	3.3 (1.8-6.4)	3.5 (1.6-7.7)	3.5 (2.0-6.2)	3.3 (1.6-6.8)
Moderate (1-4 teeth)	2.3 (1.5-3.5)	2.0 (1.2-3.4)	1.9 (1.3-2.8)	1.5 (1.0-2.4)	2.3 (1.5-3.5)	2.0 (1.2-3.4)	2.0 (1.4-2.8)	1.6 (1.0-2.4)
None	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Child's Age in Years	1.8 (1.5-2.0)	1.9 (1.7-2.1)	1.3 (1.2-1.5)	1.4 (1.2-1.6)	1.7 (1.5-1.9)	1.8 (1.6-2.1)	1.3 (1.2-1.5)	1.4 (1.2-1.6)
Mother's Age in Years	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (1.0-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)	1.0 (0.9-1.0)
Race/Ethnicity								
Mexican American	2.2 (1.3-3.5)	2.6 (1.6-4.3)	3.3 (2.0-5.5)	3.1 (1.8-5.3)	2.4 (1.4-3.9)	3.0 (1.8-5.0)	3.5 (2.1-5.6)	3.3 (1.9-5.7)
Non-Hispanic black	1.5 (1.0-2.3)	1.3 (0.8-2.1)	1.9 (1.2-3.2)	1.4 (0.8-2.7)	1.5 (1.0-2.2)	1.3 (0.8-2.1)	1.9 (1.2-3.2)	1.4 (0.8-2.7)
Non-Hispanic white	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
FPT¶								
Poor	2.4 (1.2-5.0)	1.1 (0.4-2.9)	3.5 (1.5-8.0)	1.6 (0.6-4.4)	2.5 (1.2-5.4)	1.2 (0.5-3.1)	3.6 (1.6-8.1)	1.8 (0.7-4.6)
Near poor	2.3 (1.3-4.3)	1.7 (0.8-3.7)	2.6 (1.2-5.4)	1.7 (0.7-4.0)	2.2 (1.2-4.0)	1.6 (0.8-3.2)	2.6 (1.3-5.4)	1.8 (0.8-4.0)
Nonpoor	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference

* Source: Third National Health and Nutrition Examination Survey.²⁵
† Logistic regression requires the outcome variable to be two levels (yes or no).
‡ OR: Odds ratio.
§ CI: Confidence interval.
¶ FPT: Federal poverty thresholds. Less than 100 percent of FPT is poor, 100-299 percent of FPT is near poor and ≥ 300 percent of FPT is nonpoor.

associated with higher levels of caries experience and untreated caries in children, even after we adjusted for race/ethnicity and poverty status. In cumulative logistic models in which we adjusted for race/ethnicity, poverty status and ages of the mothers and children, the results show that children of mothers with high levels of tooth loss were more likely to have had higher levels of caries experience and untreated caries than were children whose mothers had no tooth loss. As was the case in the adjusted logistic regression models, we found that moderate tooth loss among mothers did not significantly affect their children's untreated caries status in the multivariable cumulative modeling.

DISCUSSION

In this study, we used data from NHANES III to determine if an association existed between the oral health status of mothers and that of their

children. We found that compared with mothers who had no untreated caries, mothers who had high levels of untreated caries were more than three times as likely to have children who had an increasing extent of caries experience (that is, treated or untreated dental caries). We observed a similar relationship between mothers' tooth loss and the extent of caries experience and untreated caries among their children.

ECC appears to be increasing among children of preschool age.¹ This raises questions regarding the effectiveness of current caries prevention programs and current research directions in health promotion and ECC prevention. Given the influence of external factors (such as the mother's oral health status, poverty, race/ethnicity) on ECC, it has been well established that addressing ECC on an individual basis with restorations is equivalent to treating

the disease in a vacuum.³⁷ The continued underutilization of preventive dental visits and prevalence of ECC among socially disadvantaged children support the view that caries prevention programs have failed.^{14,38} Milgrom¹⁴ recommended that caries prevention programs for children involve consideration of the particular circumstances of mothers; however, if the intervention is too taxing on mothers' resources, the intervention is likely to fail.³⁹ Mothers of lower socioeconomic status are more likely to be burdened by the pressures of securing housing, food, income and transportation,⁴⁰ thus preventing dental care from becoming a high priority.³⁸ Consequently, these mothers tend to have a fatalistic perspective regarding dental care,⁴¹ which, according to Golletz and colleagues,⁴² usually has been exacerbated by negative dental care experiences.

Addressing ECC. An effective strategy for dealing with ECC may include addressing the MS levels in mothers and increasing their oral health literacy along with providing anticipatory guidance. Findings from a recent study suggest that an oral health program based on providing proactive and repeated counseling (that is, anticipatory guidance)

begun during a woman's pregnancy was successful in reducing severe ECC.⁴³ In a recent study involving poor African-American mothers and their children, Finlayson and colleagues⁴⁴ concluded that there was a significant relationship between mothers' toothbrushing at bedtime and their preschool-aged children's toothbrushing. In addition, Grembowski and colleagues¹⁸ showed that for young children enrolled in Medicaid, increasing their mothers' access to dental care may increase the children's use of dental and preventive care services, which, in turn, may reduce racial and ethnic inequalities in oral health.

Our data show a strong relationship between poor oral health of mothers and the prevalence of ECC in their children, regardless of the effects of poverty status. Reisine and colleagues⁴⁵ reported findings for black mothers in Detroit that were consistent with ours, as did Weintraub and colleagues⁴⁶ for Hispanics in a rural area of California. Although the burden of ECC may affect more children from families that are economically disadvantaged, some groups of young children who experience increasing caries in primary teeth live in non-poor families⁵ in which financial support, oral

health knowledge and access to insurance coverage may be less important factors in facilitating poor maternal and children's oral health. In this population, disrupting MS transmission and promoting healthful eating habits might be an effective strategy to prevent ECC.

In an earlier study involving the use of NHANES III data, Dye and colleagues³² showed that poor eating habits were associated with untreated caries in preschool children living in households that were not poor. The fact that poverty was significant in unadjusted models but not in the multivariate models suggests that poverty may work through the mother's oral health status. In other words, poverty may influence maternal oral health status more significantly than it influences a child's oral health status. In analyses not shown here, education produced similar results. Because education and poverty are highly correlated with regard to oral health outcomes, we elected to work with poverty status given its relevance to public health activities.

Race/ethnicity. Another important finding of our study is the influence of race/ethnicity on the child's caries status. It is well accepted that caries risk generally is higher among racial and ethnic minorities than it is among non-Hispanic whites in the United States. However, our results support the notion that the effect of race/ethnicity may be much more selective than originally believed. Although unadjusted results from regression models in our study indicated that children whose mothers were non-Hispanic black were nearly twice as likely as children whose mothers were non-Hispanic white to have untreated caries (Table 3), the association was no longer significant after we adjusted for maternal untreated caries, the mother's and child's ages and their poverty status. We observed a similar pattern in the assessment of increasing untreated caries levels in children (the cumulative logistic models). In contrast, Mexican-American ethnicity remained a significant factor for untreated caries in children even after we adjusted for important sociodemographic covariates and maternal untreated caries status, suggesting that there may be strong underlying cultural influences that promote caries development in some children.

Our findings show that a child's caries experience (that is, treated and untreated caries) is associated with his or her mother's untreated

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The study findings show that a child's caries experience is associated with his or her mother's untreated caries and tooth loss.

caries and tooth loss, regardless of the extent of the untreated caries or the severity of tooth loss in their mothers. However, a child's untreated caries status is associated only with high levels of maternal untreated caries and tooth loss. These findings suggest that mothers with less-than-extensive oral health problems (for example, moderate levels of untreated caries or tooth loss) may be just as likely to adequately address their children's untreated dental caries needs as are mothers with no tooth loss or untreated caries. This raises an important question for future studies regarding whether substantially improving a mother's oral health status will result in an effective prevention strategy for ECC.

Study limitations. This study has some limitations that one should keep in mind when interpreting estimates of the relationship between poor maternal oral health and the caries status of young children. Because we used a subsample of children aged 2 through 6 years who participated in NHANES III for these analyses, the possibility exists of selection and nonresponse bias affecting the findings. We conducted a series of preliminary analyses to determine whether the selected subsample was reflective of the national population. Using statistical software (SUDAAN) to account for oversampling, nonresponse and the complex survey design, we produced national estimates for the mother's age at the time of delivery and related demographic characteristics and then compared these estimates with the "official" national estimates compiled at NCHS⁴⁷ to determine if our study sample of mothers was similar. Consequently, we concluded that reweighting of our analytical sample was not necessary. We incorporated a series of multiple criteria to enhance the probability that the child was related biologically to the matched mother. However, a small number of children may have been paired with women who were not their biological mothers. Another limitation of our study was the use of cross-sectional data, which prevented the establishment of any temporal relationships.

Despite these issues, our analytical approach and the use of NHANES III data minimize the potential of confounding, including a possible clustering effect of poor oral health as a result of assigning multiple children to a single mother in the same household. The rigorous selection methodology of NHANES III promotes a broader representation of various subgroups in sufficient numbers that minimizes selection bias and allows for adequate statistical analyses to be performed. An important strength of our

study was using the linked birth certificate information to create, with a high level of certainty, mother/child pairs that yielded a distribution of race/ethnicity characteristics similar to those in national vital health statistics. Finally, the use of NHANES data enabled us to quantify, for the first time to our knowledge, the association between the oral health status of a mother and that of her child in a sample of study participants selected from the U.S. population.

CONCLUSIONS

The results of our study show that higher levels of untreated caries or tooth loss among mothers is a strong indicator of greater dental caries in their children, and the effect of poor maternal oral health on children's oral health is significant regardless of poverty status. Thus, clinicians may consider dental caries in the mother as a risk indicator for caries activity in her child. Our findings suggest that reducing caries in young children may require improving the oral health of their mothers. ■

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