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ABSTRACT

There are many determinants of children's dental caries. We hypothesized that a mother's untreated caries was associated with increased likelihood of her children's untreated caries, after controlling for other factors. This population-based study was conducted in a rural, primarily Hispanic, California community. Interview and dental examination data for mother-child (children < 18 yrs old) dyads were analyzed. In a Generalized Estimation Equation (GEE) logit model for mothers (n = 179) and children (n = 387), maternal untreated caries was a statistically significant correlate of child's untreated caries, odds ratio (OR) = 1.76 (95%CI: 1.10, 2.70), adjusted for demographic factors. This relationship did not change when behavioral and dental utilization factors were added to the model, OR = 1.85 (95% CI: 1.12, 3.07). Maternal untreated caries almost doubled the odds of children's untreated caries and significantly increased child's caries severity by about 3 surfaces. Caries prevention and dental utilization programs for mothers and their children should be increased.

KEY WORDS: dental caries, oral health disparities, mother-child relations, family health, child.

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INTRODUCTION

Many analyses of children's dental caries focus on individual-level caries risk and protective factors. However, family factors can play an important role in the child's diet, oral health behaviors, and dental utilization (Fisher-Owens *et al*., 2007; Poutanen *et al*., 2007; Weintraub, 2007; Reisine *et al*., 2008), as can possible genetic and other biologic factors (Bedos *et al*., 2005; Weintraub, 2007; Vieira *et al*., 2008). Transmission of cariogenic bacteria from mothers to their young children has been documented (Li and Caufield, 1995).

The relationship between parents' and children's oral health has been studied at least since 1946 (Klein, 1946). In Klein's descriptive study of about 3000 offspring in 1150 families of Japanese ancestry, the DMFT category (low, middle, high) of 15- to 19-year-olds from parents who both had high caries levels was about double that of children from parents who both had low caries levels. In a Maryland study (Ringelberg *et al.,* 1974), each parent's DMFS, stratified into 3 disease levels, was significantly related to his/her 6- to 32-year-old children's caries status, after age adjustment. The relationship was stronger for the mothers' caries status than the fathers'. Mothers' caries status was related to preschool children's caries status in Turkey (Ersin *et al.*, 2006), Thailand (Thitasomakul *et al.*, 2009), and New York (Smith *et al*., 2002), but was not significant in a Japanese study (Kawashita *et al*., 2009). In Finland (Mattila *et al*., 2000), fathers' caries index was a stronger predictor of dmft in 5-year-olds, but the mothers' prior caries status was a stronger predictor of the child's caries status at age 10 yrs (Mattila *et al*., 2005). In Quebec, Canada, 5- to 9-year-olds with edentulous mothers were found to have higher caries risk than children with dentate mothers (Bedos *et al*., 2005). Among African-American caregivers and their preschool children living in the economically disadvantaged area of Detroit, Michigan (Reisine *et al*., 2008), children's (non-cavitated and cavitated) carious surfaces and teeth increased with caregivers' (non-cavitated and cavitated) carious surfaces when demographic factors were controlled.

In the United States, Hispanic children and those from low-income families have higher caries prevalence than other racial/ethnic and economic groups (Dye *et al.,* 2007). This current analysis was designed to determine if mothers' untreated caries is associated with increased likelihood of their children's untreated caries and increased caries severity, after controlling for demographic and other factors in a population-based study of low-income Hispanic families in California.

METHODS

In 2006, the University of California, Davis (UCD) launched an occupational and environmental agricultural worker health study in Mendota, a rural, low-income, primarily Hispanic community in California's Central Valley (Schenker *et al.,* 2006). UCD invited the University of California, San Francisco's (UCSF) Center to Address Disparities in Children's Oral Health to add a dental component to its population-based study.

The dental study was approved by the UCSF Institutional Review Board prior to initiation. Mendota is about 160 miles southeast of San Francisco in Fresno County. Its year-round population of about 10,000 increases during the harvest season, mostly with single men; 95% of the residents are Hispanic (city-data.com).

Eligibility Criteria

UCD conducted an epidemiologic, population-based study with a two-stage sampling process. Eligible census tracts were identified, followed by door-to-door enumeration of households with at least one adult, age 18-55 yrs, self-identified as Hispanic, who had worked in agriculture for at least 30 days in the prior year. There were 2441 adults enumerated in 751 households. A random sample of 445 family households was selected (and 41 solo male households). The UCSF dental study included the subsample of households from the UCD study that included at least one child under age 18 yrs living at home.

Recruitment and Enrollment

After the UCD household interview, families were asked if they could be contacted about the dental study. Local bilingual interviewers contacted families. Families were offered free dental examinations at the local field office, a toothbrush, and a $15 gift certificate to a local market for each interview and dental examination completed. Parents, caregivers, and children age 1-17 yrs residing in the home were eligible to participate. Informed consent, in English or Spanish, was obtained from parents for themselves and their children. Assent was also obtained from children age 7 yrs and older.

Data Collection

Questionnaire data were collected in participants' homes by two local bilingual interviewers. Adults were interviewed about themselves and their children. Children age 7 yrs and older completed the Children's Oral Health Impact Profile if they were able (Broder *et al*., 2007). The interviewer collected demographic information about the family, self-reported information about the parents' oral health, dental utilization, and parent and child oral health behaviors, particularly factors related to dental caries.

All dental examinations were conducted by one dental examiner (ML), a previously trained dental examiner for the National Health and Nutrition Examination Survey (NHANES). Portable dental equipment was used in a local field office, and no radiographs were exposed. NHANES (CDC, 2001) examination criteria were used, though not all NHANES clinical measures were collected, and oral hygiene measures were added. Clinical data were directly entered into a secure, MS Access program (Microsoft Corp, Redmond, WA, USA) on a computer.

Data Analysis

This analysis was limited to households with questionnaire and dental examination data for both a mother and a least one child. Generalized estimation equation (GEE) logit models accounting for within-family clustering (multiple children *per* mother) were used for data analysis. The primary outcome variable was whether the child had any untreated caries in the primary or permanent dentition [(ds+DS) > 0]; the secondary outcome variable was the amount of untreated caries in the child (ds+DS). The primary explanatory variable was whether the mother had any untreated caries (DS > 0). Descriptive statistics were obtained, and variables in similar domains were tested for multicollinearity. The logistic and negative binomial statistical model-building approach was designed to have 4 phases, because of the limited sample size and the desire not to overfit the model with too many variables. The first model included only the primary explanatory variable, mother's untreated caries, so that we could obtain the unadjusted odds ratio (OR). Model 2 included mother and child demographic variables so that we could obtain an adjusted OR for these factors. Model 3 did not include demographic variables, but instead included mother and child behavioral and dental utilization variables. Variables significant in Model 3 were to be added to Model 4 along with the mother and child demographic variables. The same model-fitting strategy was applied with the child's untreated caries score (ds+DS) used as the caries severity outcome variable and mother's untreated caries (DS > 0) used as an explanatory variable. GEE was also used to fit the untreated caries count with a negative binomial distribution. The regression coefficient was exponentiated for estimation of the number of children's decayed surfaces differing by mother's caries status.

RESULTS

Demographics

This analysis included 179 mothers and their 387 children; 46% of mothers and 27% of children had untreated caries (Table 1). The mothers had a mean age (SD) of 36 (8.1) yrs, ranging from 19 to 55 yrs. Only 5% were born in the United States; most were born in Mexico or El Salvador. Their education and income levels were low. The children had a mean (SD) age of 8.6 (4.6) yrs, half were girls, and 66% were born in the United States.

Behavioral and Dental Utilization Factors

According to parental reports, 56% of the children started toothbrushing by age 2 yrs, and 58% had received a topical fluoride application or dental sealant. Only a third of the mothers had ever received a professional toothcleaning. Most mothers, 79.8%, reported their oral health as being fair or poor. Most mothers and children had had a dental visit within the prior 2 yrs; 5.7% of mothers and 19.1% of children had never had a dental visit. One-third of mothers and 84.4% of children had dental insurance, primarily Medicaid.

Table 1. Characteristics of Mothers and Their Children, Overall and by Untreated Caries Status

Mothers' Demographic Factors	Mothers, all (n = 179)	DS = 0 (n = 97)	DS > 0 (n = 82)
Mean age (SD)	36 (8.1)	36 (8.3)	36 (8.0)
Range (yrs)	19-55	20-55	19-55
Birth country, % US	5.2	4.2	6.3
Mother's education			
Mean yrs (SD)	6.9 (3.8)	7.1 (3.7)	6.5 (4.0)
Family income, Modal category	$10,001-$20,000	$10,001-$20,000	$10,001-$20,000
Behavioral factors			
Prophylaxis, % ever	33.5	39.2	26.8
Perceived oral health, % fair/poor	79.8	76.6	83.5
Dental utilization factors			
Dental insurance, % any	34.3	36.2	32.1
Last dental visit			
% < 2 yrs	63.3	65.0	61.3
% 2-5 yrs	16.4	17.5	15.0
% > 5 yrs	14.7	11.3	18.8
% never	5.7	6.2	5.0
Dental caries status			
% DS > 0 (any untreated caries)	45.8	0	100
DFS (Mean, SD)	13.5 (13.0)	14.3 (14.4)	12.6 (11.2)
DS (Mean, SD)	1.2 (1.7)	0	2.5 (1.8)
Children's demographic factors	Children, all (n = 387)	(ds+DS) = 0 (n = 284)	(ds+DS) > 0 (n = 103)
Mean age (SD)	8.6 (4.6)	8.6 (4.7)	8.5 (4.4)
Range (yrs)	1-17	1-17	1-17
Birth country, % US	66.2	68.9	59.0
Child's gender, % female	48.7	49.3	47.0
Behavioral factors			
Age started toothbrushing, % age ≤ 2 yrs	55.7	55.8	55.6
Topical fluoride/sealant, % ever	58.1	56.3	62.8
Dental utilization factors			
Dental insurance, % any	84.4	86.5	78.4
Last dental visit			
% ≤ 2 yrs	65.0	67.2	58.8
% > 2 yrs	15.9	16.1	15.5
% never	19.1	16.8	25.8
Dental caries status			
% (ds+DS) > 0	26.6	0	100
dfs (Mean, SD)	6.8 (10.2) [a]	5.9 (10.3)	9.4 (9.3)
DFS (Mean, SD)	4.3 (7.3) [b]	4.3 (7.0)	4.2 (8.1)
dfs+DFS (Mean, SD)	7.7 (10.0) [c]	6.9 (10.0)	9.9 (9.8)
ds (Mean, SD)	0.9 (2.8)	0	3.3 (4.5)
DS (Mean, SD)	0.3 (0.9)	0	1.0 (1.5)
(ds+DS) (Mean, SD)	0.8 (2.5)	0	3.0 (3.9)

[a] Based on 259 children with at least one primary tooth.
[b] Based on 280 children with at least one permanent tooth.
[c] Based on 385 children with primary teeth only, permanent teeth only, or mixed dentition.

Caries Status

About half the mothers (46%) had untreated caries. Their mean (SD) DFS was 13.5 (13.0), affecting about half of their teeth. Their mean DS (SD) was 1.2 (1.7) overall, and 2.5 (1.8) for those with any untreated caries. Over one-fourth of children, 27%, had any untreated caries in their primary or permanent dentition. The mean (SD) dfs was 6.8 (10.2), and DFS was 4.3 (7.3).

Statistical Models

All 4 models indicated that maternal untreated caries was significantly associated with increased likelihood of child's untreated caries (Table 2). The unadjusted OR (95% Confidence Interval) for mother's untreated caries associated with child's untreated caries was 1.73 (1.10, 2.70). The OR remained almost the same (OR 1.76, 95% CI 1.08, 2.88) after adjustment for mother and child demographic variables (mothers' age, education, family income, child's age, gender, and whether US-born). The only demographic variable significant in this model was whether the child was US-born ($p = 0.03$). In Model 3, none of the behavioral or demographic variables added was significant (all $p > 0.10$), except whether the child had dental insurance was borderline significant ($p = 0.083$). The OR increased to 1.89 (95% CI, 1.11, 3.22). The child dental insurance variable and all the demographic variables are in Model 4. None of the variables was significant except whether the mother had any untreated

caries, which had an OR (95% CI) of 1.85 (1.12, 3.07). When we fit the data to the child's number of untreated carious primary and permanent surfaces, mother's untreated caries remained a highly significant variable (p = 0.001) after adjustment for the mother's age (p = 0.03), the child being US-born (p = 0.01), and whether the mother received a professional toothcleaning (p = 0.01). In the negative binomial models, children had about 3 more decayed surfaces when their mothers had untreated caries, compared with children whose mothers did not have untreated caries (Appendix Table).

DISCUSSION

In this cross-sectional study of Hispanic mother-child dyads in a low-income community, maternal untreated caries almost doubled the odds of children's untreated caries. This factor was the only one significantly associated with the child having any untreated caries after adjustment for demographic, behavioral, and dental utilization variables. These findings have important implications. Dental prevention and treatment approaches are traditionally focused on the individual in the dental chair or the child in a preschool or school-based prevention program. The multilevel conceptual model of children's oral health determinants developed by Fisher-Owens and colleagues (Fisher-Owens *et al.,* 2007) expanded the traditional dental caries model (Keyes, 1962) of the interactions within the oral cavity to include child, family, and community-level influences that vary over time. Our findings highlight the importance of family-level factors for a wide age range of children.

Many of the earlier cross-sectional studies examining this relationship either focused exclusively on preschool children and/or used small convenience samples. In a representative sample of Quebec children, those with edentulous mothers had a higher caries prevalence than those with dentate mothers. The investigators assumed that the edentulous mothers' tooth loss was due to high prior caries prevalence, and the caries status of the dentate mothers was not specified (Bedos *et al*., 2005). In Iowa, caregivers' responses to a screening questionnaire reporting tooth loss due to caries were significantly associated with young children's caries prevalence (Roberts *et al*., 2009). The Detroit study (Reisine *et al*., 2008) was most similar in design to this Mendota study. It included a representative sample of African-American children and caregivers. The findings, similar to those for this Hispanic population, were that higher caries prevalence among caregivers increased the likelihood of children's caries lesions, after adjustment for demographic characteristics. The Finnish Family Competence Study used a population-based cohort of initially pregnant women (Mattila *et al*., 2000, 2005). Findings varied by age of child, but family factors continued to be important.

"Family dentistry" is often advertised and should be truly practiced. Dentists treating children should encourage their mothers to receive dental care and educate them about healthy oral health practices for themselves and their children. Similarly, dentists treating parents should inquire about their children's oral health. In addition to dental restorations, antibacterial and fluoride regimens may be needed to restore the oral cavity to a healthy balance to prevent disease recurrence (Featherstone, 2000). Untreated caries is a modifiable risk factor for future caries. Children's caries risk assessment tools that include an indicator for mother or primary caregivers' caries status have been developed by expert panels and are being promoted by different professional organizations (American Academy of Pediatric Dentistry, 2006; Ramos-Gomez *et al*., 2007; American Dental Association, 2008).

This study has several limitations. Because of the cross-sectional, epidemiologic nature of the design, the chronological sequence of events cannot be determined. Although fathers were included in the larger dental study, many did not keep their dental examination appointments, and thus were not included in this analysis. Of the men examined (n = 84), 45% had untreated caries, their mean DFS (SD) was 9.5 (10.9), and 19% had never been to a dentist. Thus, the fathers could have also played a role in the transmission of cariogenic bacteria or unhealthy oral health behaviors. Not all possible caries risk and protective factors were assessed, and biologic samples were not collected. Because dietary factors were assessed differently for different age groups, dietary variables were not included in this analysis.

Table 2. Odds Ratios for Mothers' Untreated Caries Relating to Child's Untreated Caries in Primary or Permanent Dentition, Models Unadjusted and Adjusted for Demographic and/or Behavioral and Dental Utilization Variables

Model	Variable	OR	95% C.I.	GEE Logit p
1	Unadjusted	1.73	1.10, 2.70	0.017
2	Adjusted for demographics	1.76	1.08, 2.88	0.023
	Mother's age			0.785
	Mother's education			0.684
	Child's age			0.844
	Child US-born			0.034
	Child's gender (male)			0.682
	Family income			0.690
3	Adjusted for behavioral and dental utilization variables	1.89	1.11, 3.22	0.012
	Child:			
	Dental insurance			0.083
	Age started brushing [a]			0.679
	Ever fluoride/sealant			0.572
	Last dental visit [b]			0.414
	Mother:			
	Dental insurance,			0.986
	Last dental visit [c]			0.530
	Ever prophylaxis			0.852
	Fair/Poor Oral Health			0.543
4	Adjusted for demographics and child's dental insurance	1.85	1.12, 3.07	0.017
	Child's dental insurance			0.123
	Mother's age			0.858
	Mother's education			0.716
	Child's age			0.849
	Child US-born			0.180
	Child's gender (male)			0.811
	Family income			0.702

[a] Child's age when toothbrushing started, ≤ 2 yrs *vs.* > 2 yrs or no brushing.
[b] Child's last dental visit was ≤ 2 yrs *vs.* > 2 yrs or never.
[c] Mom's last dental visit was ≤ 5 yrs *vs.* > 5 yrs or never.

Because of the sample size and caries prevalence, a single model could not assess the effects of many simultaneous factors concurrently. All the families in this study resided in one small community; thus, neighborhood factors, such as those shown to be important in Detroit (Tellez *et al*., 2006), were not applicable. The results may not be generalizable to other populations with better oral health.

In this disadvantaged, rural, Hispanic population, the untreated caries prevalence was high, particularly among the mothers. These families have many competing priorities, and share language and other access barriers with other immigrant groups (Arcury and Quandt, 2007). Strategies are needed to increase caries prevention and dental utilization for both mothers and their children and adolescents, to improve their oral health.

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