The Association of Early Childhood Caries and Race/Ethnicity among California Preschool Children

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Abstract

Objectives: This paper explores the role of race/ethnicity in the occurrence of early childhood caries (ECC) among California Head Start (HS) and non-HS preschool children. Methods: Using oral examination and questionnaire data from the 1993–94 California Oral Health Needs Assessment of Children, we computed the prevalence of ECC using various definitions and fitted logistic regression models to explore the effect of race/ethnicity on ECC, separately for HS and non-HS children, adjusting for bedtime feeding habits and other covariates. Results: Among 2,520 children, the largest proportion with a history of falling asleep sipping milk/sweet substance was among Latinos/Hispanics (72% among HS and 65% among non-HS) and HS Asians (56%). HS Asians and Latinos/Hispanics had the largest prevalence of ECC (30%–33%) and untreated caries (49%–54%). The estimated risk for ECC was more than three times higher in HS Asians compared to HS whites and among non-HS African Americans and Asians compared to non-HS whites controlling for socioeconomic status variables. The risk of ECC was also significantly higher among children who fell asleep while sipping milk or any sweet substance compared to those who did not. Conclusion: Studies of the cultural/behavioral patterns that may be specific to ethnic subgroups with the highest risk for ECC seem essential to the development of effective prevention strategies. [J Public Health Dent 2003;63(1):38-46].

Key Words: dental caries, preschool, race/ethnicity, Head Start, socioeconomic status, feeding practices.

California is among the most populated and ethnically diverse states in the country. It is also among the states with the lowest proportion of the population with access to optimally fluoridated drinking water. Despite the well-known benefits of communal water fluoridation in the prevention of dental caries (1-4), before 1995 only 16 percent of all Californians had access to optimally fluoridated water, compared to 62 percent of the US population (5). Even though caries prevalence among US children has been declining in the past several decades (6), the 1986–87 National Survey of Dental Caries in US Schoolchildren revealed that caries risk varied by geographic area and race, and that the highest caries experience was found in blacks in Region VII (California and other western states) (7).

A study of Head Start children in California and the Pacific Islands revealed a very high prevalence of caries among Asians (8). In the national sample recruited as part of the Third National Health and Nutrition Examination Survey, 8.4 percent of 2-year-old children and over 40 percent of 5-year-old children were found to have at least one decayed or filled tooth (9). The prevalence of caries was especially high among Native Americans, Mexican Americans, and African Americans. The recent inaugural Surgeon General's Report on Oral Health referenced several studies in which

Latinos were found to have a greater risk of developing dental disease than white and African-American children (10). Therefore, we believe it is important to determine whether children from certain racial/ethnic backgrounds are at higher risk for dental caries after accounting for socioeconomic status and other potential confounders. This is particularly relevant for early childhood caries (ECC), previously termed nursing caries or baby bottle tooth decay, which is a specific form of devastating caries that affects the primary dentition and may begin as soon as an infant's teeth erupt.

ECC is thought to be a multifactorial condition with a complex etiology that includes the interaction of deleterious feeding patterns in infancy with the presence of unusually high levels of *Streptococcus mutans* in the oral cavity. It seems to affect predominantly children of certain ethnic origins, particularly Native Americans, and children from lower socioeconomic backgrounds (11,12). ECC can lead to caries in the permanent dentition and malocclusion, and may be associated with poor speech articulation (13,14), retarded growth, and social ostracism (15).

The objective of this analysis was to explore the role played by race/ethnicity, controlling for other sociodemographic variables, in the occurrence of ECC among HS and non-HS preschool children, so that future prevention strategies may be better targeted toward vulnerable populations.

Methods

Study Design and Population. We used data collected as part of the California Oral Health Needs Assessment

of Children (COHNAC) for this analysis. The COHNAC, a cross-sectional survey of children conducted from October 1, 1993, to January 31, 1994, has been described previously (16). The survey included preschool, grade K-3, and high school children, but the present analysis focuses on preschool children. The COHNAC used a stratified sampling scheme in which the 10 geographic regions (12 counties) that constituted the primary sampling units were selected on the basis of fluoridation status: three were fluoridated urban regions, two were rural (nonfluoridated), and five were nonfluoridated urban regions. These counties represented 12 of the 13 most populated counties of California, and comprised 77 percent of California schoolchildren. The 1991 California Health and Welfare Agency data file, which listed all private and public preschools in California, was used to identify preschools. They were grouped within each geographic stratum into Head Start (HS) and non-Head Start (non-HS). Five preschools were randomly selected within each stratum. If the director of a preschool refused to participate, another preschool from the same stratum was selected. A total of 122 preschools were targeted (60 HS in a sampling frame of 467, and 62 non-HS in a sampling frame of 5,514). The COHNAC targeted as many HS as non-HS preschools to capture a sufficient number of low-income children to explore unmet needs. All parents/guardians of children at participating preschools were invited to participate.

The study protocol was approved by the California Health and Welfare Agency, Committee for the Protection of Human Subjects. Written consent was sought and obtained from preschool directors and from all parents of participating children.

Data Collection Methods and Variables. Parents/guardians filled out a standardized questionnaire providing information on sociodemographic variables, fluoride supplement intake, bedtime/nap time feeding practices, and dental insurance status. The question regarding which racial/ethnic group best described each child offered the choice from among four main categories: Asian/Pacific Islander included nine selections or subgroups, non-Asian included four (African American/black, Middle East-

ern, Native American/American Indian, or white/Caucasian), and Latino/Hispanic included three (Mexican American, Central American, other Latino). "Multiethnic" or "other" were also among the four main categories. At the analysis stage, all Asians/Pacific Islanders were grouped together, and the Native American and Middle Eastern, who represented a very small proportion, were grouped as "other/multiethnic." Several focus groups consisting of pediatric dentists and dental public health experts experienced in ECC research were organized to develop the standardized questionnaire. Whenever possible, questions validated in prior instruments were used.

The question designed to measure bedtime/nap time feeding practices required parents to choose among 10 answers which one best described how their child most often went to sleep or took a nap at 12 months of age and at the time of the survey. At the analysis stage we dichotomized this variable by grouping all children whose parents reported that their child most commonly fell asleep sucking on a bottle containing milk, juice, or any sweetened substance; "with a pacifier dipped in a sweet substance"; or "with something sweet in the mouth." The other group consisted of children who fell asleep "without anything in the mouth," or "sucking a thumb or finger," or "with a bottle of water."

Each child received a comprehensive oral examination by trained dentists using the National Institute for Dental Research (NIDR) criteria (17), as they were then called. Thirteen dentists conducted oral examinations after they participated in two training sessions, and their measurements were calibrated against those of the principal investigator (HP). The examination was performed using a #23 sickle-shaped explorer and an unmarred, nonmagnifying, front surface mirror. It included the recording of the decayed, missing, or filled surfaces (dmfs) and decayed, missing, or filled teeth (dmft) indices for deciduous dentition. The dmf is a modification of the def index used in children before the age of exfoliation, with "m" indicating teeth missing due to caries (18). No radiographs were taken. Oral examination data were entered during the exam on laptop computers. Inter-

examiner agreement was assessed by pairing examiners when feasible. Questionnaire and oral examination data were collected twice by two different examiners on 90 children (from 10 preschools, three elementary schools, and one high school), yielding an interexaminer agreement of 96.3 percent.

Data Analysis. For this analysis we used proportions to summarize sample characteristics by race/ethnic group and HS status. We computed chi-square or Fisher's Exact tests to compare sociodemographic variables between the children who received an oral examination and those who did not. Because specific subgroups were oversampled to capture major ethnic groups, we applied the relevant weights in all analyses of oral disease outcomes so that our results could be generalized to California preschool children (separate weights were used for the HS and non-HS groups). Sampling weights were defined as the product of the following factors:

• School weight: inverse of the probability of school selection.

• Ethnicity: poststratification weights were used to adjust the sample to represent the same ethnicity distribution found among preschool-aged children (3–4-year-olds) in California using the 1990 Census data (19) for non-HS children and data obtained from the 1992–93 California HS Program Information Report for HS children (16).

After stratifying by race/ethnicity and HS status, we computed weighted proportions for the following outcomes: at least two decayed or filled primary maxillary incisors (as our main definition of ECC); at least two decayed primary maxillary incisors (untreated ECC); at least one decayed or filled primary maxillary incisor (as a broader definition of ECC); at least one decayed primary maxillary incisor; "dmft," categorized into four groups (0, 1–4, 5–8, and ≥9); the "%d/dmft" to determine what percentage of dmft was due to decayed teeth; and "untreated dental caries," defined as presence of untreated caries on any deciduous tooth. We also computed weighted mean dmfs scores by race/ethnicity and HS status.

The proposed new case definition for ECC, developed as part of a workshop sponsored in part by the National Institute of Dental and Cranio-

facial Research, requires a dmfs >0 and includes both noncavitated and cavitated decayed teeth or tooth surfaces (20). Our survey was conducted prior to the development of this new diagnostic criteria, and the decayed component of the dmft index included only cavitated decayed teeth (following the 1991 NIDR criteria) (17). Therefore, our main definition of ECC is based on the case definition that was most commonly used at the time of our survey (at least two decayed or filled primary maxillary incisors) to allow comparability with other studies. Our results also include the proportion of children with dmft <0 (by race/ethnicity and HS status), which does provide some comparability with studies using the new case definition even though "white spot lesions" are not included as decayed surfaces.

We fitted logistic regression models to explore the probability of ECC (main definition); in relation to race/ethnicity while controlling for selected covariates. The relevant weights were applied when fitting the multivariate model using SUDAAN (21). Adjusted odds ratios (aOR) were used to estimate relative risk of having ECC. The logistic model included all independent variables that were associated with the outcome at the 0.1 level of significance in the unadjusted, weighted logistic regression of only that variable with the response, and suspected confounders. If significant, the model was refitted with cross classification of HS status and race/ethnicity using non-HS white as the reference group; then the same model was refitted with HS white as the reference group to make interpretation easier without changing the estimates of the other covariates. This approach allowed more efficient assessment of the other covariates than fitting separate models for HS and non-HS groups, but yielded similar regression coefficients. We assessed goodness of fit with the Hosmer-Lemeshow statistical test (22).

Results

Sample Characteristics. A total of 44 HS preschools (among 60 targeted; 73%) and 40 non-HS preschools (among 62 targeted; 65%) agreed to enroll. The response rate for the questionnaire was estimated as 2,649/4,002 (66%) for all preschools. The denominator for this estimate ex-

cludes questionnaires sent to preschools whose director declined to participate (31%). Some children whose parents returned a signed consent and completed the questionnaire did not receive an oral examination because they were not in preschool on the day the dentist/study team visited. We found no statistically significant differences, with respect to sociodemographic characteristics, between children who received (N=2,520) and those who did not receive (N=129) an oral examination.

Latinos/Hispanics represented the largest ethnic group (49%) among HS children, and whites (36%) predominated in the non-HS group followed by Latinos (25%) (Table 1). More than 80 percent of the Latino group (HS or non-HS) were Mexican American, 10 percent were Central American, and 10 percent described themselves as "other Latino." Three non-HS and 14 HS children were Native Americans, while 51 non-HS and 37 HS were multiethnic; they were all grouped with the "other/multiethnic" group in the analysis. There was a similar proportion of boys and girls in the HS and non-HS samples. The majority of children were 4 years old (79% of the HS

and 51% of non-HS). A higher proportion of children in the HS group (44%) than in the non-HS group (28%) lived in a single-parent household. When exploring selected sample characteristics by race/ethnic distribution, we found that these characteristics differed widely by HS status (Table 2).

The largest proportion of children with no insurance coverage was among non-HS Asians (47%) and HS Latinos/Hispanics (32%). The largest difference in distribution of insurance type by HS status was seen in whites (71% of HS children with Medi-Cal vs 11% of non-HS children) and Asians (69% of HS children with Medi-Cal vs 21% of non-HS children). A high proportion of Latinos/Hispanics and African Americans had Medi-Cal both in HS and non-HS groups. However, one-third of HS Latinos/Hispanics had no dental insurance at all. More than half of HS Latino children, 36 percent of HS Asians, and 33 percent of non-HS Latinos/Hispanics had a parent/guardian who did not complete high school. A majority of both HS (72%) and non-HS (65%) Latino children and 56 percent of HS Asians had a history of usually falling asleep (at night or nap time) while sipping

TABLE 1
Sample Demographics by HS Status among Children Who Received Oral Examination as Part of 1993–94 COHNAC

Demographics	Head Start (N=1,445) n (%)*	Head Start (N=1,075) n (%)*
Race/ethnicity		
Latino/Hispanic	711 (49)	264 (25)
White	206 (14)	389 (36)
African American	269 (19)	143 (13)
Asian/Pacific Islander	147 (10)	165 (15)
Other/multiethnic	112 (8)	114 (11)
Sex		
Female	704 (49)	497 (46)
Male	730 (51)	575 (54)
Age (years)		
≤3	199 (14)	328 (31)
4	1,123 (79)	542 (51)
≥5	105 (7)	203 (19)
Family structure		
Single parent	555 (44)	275 (28)
Two parents	635 (51)	651 (67)
Extended parents	60 (5)	43 (4)

*Proportions may not sum up to 100% within each demographic characteristic because of rounding.

TABLE 2
Sample Characteristics by HS Status and Race/Ethnic Distribution among Children Who Received Oral Examination as Part of 1993–94 COHNAC

Characteristics	Latino (n=711) (%)*†	White (n=206) (%)*†	Afr. Am. (n=269) (%)*†	Asian (n=147) (%)*†	Other (n=112) (%)*‡	Total (N=1,445) (%)*†
Head Start						
Dental insurance status						
Private	12	16	11	12	22	13
Medi-Cal (Medicaid)	56	71	85	69	64	66
No coverage	32	13	4	19	14	22
Parent/guardian education level¶						
Not high school graduate	52	20	23	36	33	39
High school graduate	36	50	53	46	41	43
College educated	7	21	20	7	18	12
College graduate	5	9	5	11	8	7
Usually fell asleep sipping milk/sweet substance at 12 months	72	53	49	56	60	62
Usually fell asleep sipping milk/sweet substance at time of survey	12	3	4	22	6	10
Area of residence						
Urban fluoridated	24	12	46	69	24	31
Urban nonfluoridated	65	75	53	31	66	61
Rural nonfluoridated	10	13	1	0	10	8
	Latino (n=264)	White (n=389)	Afr. Am. (n=143)	Asian (n=165)	Other (n=114)	Total (n=1,075)
Non-Head Start						
Dental insurance status						
Private	28	61	43	32	53	45
Medi-Cal (Medicaid)	46	11	50	21	18	27
No coverage	26	29	7	47	30	28
Parent/guardian education level						
Not high school graduate	33	3	8	16	8	13
High school graduate	43	27	43	42	27	35
College educated	19	24	35	13	34	23
College graduate	6	46	14	28	32	28
Usually fell asleep sipping milk/sweet substance at age 12 months	65	40	45	48	50	49
Usually fell asleep sipping milk/sweet substance at time of survey	6	3	4	25	3	7
Area of residence						
Urban fluoridated	9	16	45	81	21	29
Urban nonfluoridated	25	54	51	16	57	41
Rural nonfluoridated	66	29	4	3	22	30

*Proportions may not sum up to 100% within each characteristic because of rounding.
†Standard error for proportion estimates range: 1–4%.
‡Standard error for proportion estimates range: 1–6%.
¶Parent/guardian who completed the questionnaire (85% were women).

milk, juice, or a sweetened substance from a bottle, breast-feeding, or sucking on a sweetened pacifier (at age 12 months). This behavior, which was prevalent in both HS and non-HS sam-ples, decreased substantially by the time the children were in preschool in most race/ethnic groups except for Asians, among whom 22 percent of HS and 25 percent of non-HS still fell asleep this way at time of the survey. A majority of Asian children lived in areas with fluoridated water com-pared to a small proportion of Lati-nos/Hispanics and white children in

TABLE 3
Weighted Prevalence of ECC (Using 2 Different Definitions) and dmft* by Race/Ethnicity among Children Who Received Oral Examination as Part of 1993–94 COHNAC

Caries status	Latino (n=711)† (%)‡	White (n=206)† (%)‡	Afr. Am. (n=269)† (%)‡	Asian (n=147)† (%)‡	Other (n=112)† (%)‡	Total (n=1,445)† (%)‡
Head Start						
At least 2 decayed or filled primary maxillary incisors	30	13	18	33	27	25
At least 2 decayed primary maxillary incisors	23	11	13	24	16	19
At least 1 decayed or filled primary maxillary incisor	39	19	26	44	31	33
At least 1 decayed primary maxillary incisor	27	13	18	27	22	23
dmft*						
0	34	62	47	25	41	41
1–4	33	25	28	29	35	30
5–8	21	9	17	33	13	19
≥9	13	4	8	14	11	10
%d/dmft	53	55	64	51	61	54
Untreated caries (dt>0)	49	34	45	54	48	46

	Latino (n=264)† (%)¶	White (n=389)† (%)‡	Afr. Am. (n=143)† (%)‡	Asian (n=165)† (%)‡	Other (n=114)† (%)‡	Total (n=1,075)† (%)‡
Non-Head Start						
At least 2 decayed or filled primary maxillary incisors	17	4	20	15	2	11
At least 2 decayed primary maxillary incisors	16	2	15	12	2	9
At least 1 decayed or filled primary maxillary incisor	19	5	23	16	5	13
At least 1 decayed primary maxillary incisor	18	3	18	14	5	11
dmft*						
0	60	82	57	68	82	70
1–4	25	14	30	24	13	20
5–8	10	4	7	5	1	6
≥9	6	1	6	3	3	3
%d/dmft	74	45	67	78	63	67
Untreated caries (dt>0)	39	13	38	29	15	26

*dmft: decayed, missing, or filled primary teeth.
†n represents the actual sample for each race/ethnic group, but proportions in table are weighted.
‡Standard error for proportion estimates range: 1-7%.
¶Standard error for proportion estimates range: 2-9%.

both HS and non-HS groups.

Unfortunately, 22 percent of HS parents/guardians and 14 percent of non-HS did not respond or did not know the answer to the survey question on yearly income. Among non-HS children, the highest proportions whose parents reported an annual household income ≤$19,000 were among African Americans (55%) and Latinos/Hispanics (43%) compared to 31 percent among Asians and 13 percent among whites. Thirty seven percent of African-American children were from household, with an annual income below $10,000. Because of the overall high percentage of missing income data, we used Medi-Cal status as a proxy for socioeconomic status (SES) instead of income in bivariate or multivariable analyses. This is probably a reasonable proxy because eligibility for Medi-Cal is income dependent, and the vast majority of Medi-Cal recipients live below the 200 percent poverty level (23).

Prevalence of Oral Disease. The

TABLE 4
Multivariable Analysis Modeling Probability of Having ECC* in Relation to Race/Ethnicity and Controlling for Other Cofactors among Children Who Received Oral Examination as Part of 1993–94 COHNAC (n=2,169)[†,‡,¶]

Independent Variables	Adjusted OR	95% CI
Head Start status x race/ethnicity		
Head Start (reference: white)		
Asian	3.1	1.5–6.3
African American	1.6	0.8–3.6
Latino	2.3	1.1–4.9
Other	2.1	0.7–6.6
Non-Head Status (reference: white)		
Asian	4.3	1.2–15
African American	6.3	1.6–24
Latino	2.5	0.6–11
Other	0.02	0.01–0.14
White: Head Start vs non-Head Start	2.4	0.7–9.0
Sipping milk/sweet substance while falling asleep		
At 12 months of age	4.0	1.9–8.5
At the time of survey	2.7	0.4–16
Age, years (reference: ≤3 years)		
4	1.7	0.6–5.2
≥5	7.1	2.0–25
Dental insurance (reference: no coverage)		
Medi-Cal (California Medicaid)	1.5	0.4–5.0
Private insurance	0.6	0.1–2.4
Parent (reference: two)		
Single	1.4	0.7–3.0
Extended	1.7	0.2–12
Parent/guardian education§		
High school graduate	0.4	0.2–0.8
College education	0.8	0.3–1.9
Rural area (reference: nonrural area)	1.4	0.4–3.1

*ECC is defined as having at least two decayed or filled primary maxillary incisors. †351 observations are not included in the model due to missing values for some independent variables. ‡Analysis is weighted to adjust for over-sampling of nonwhite groups. ¶Hosmer-Lemeshow goodness of fit P=.431. §Parent/guardian who completed the questionnaire.

FIGURE 1
Weighted Mean dmfs (with 95% CI) by Race/Ethnicity and Head Start Status among Preschool Children (N=2,520) Who Received Oral Examination as Part of 1993–94 COHNAC
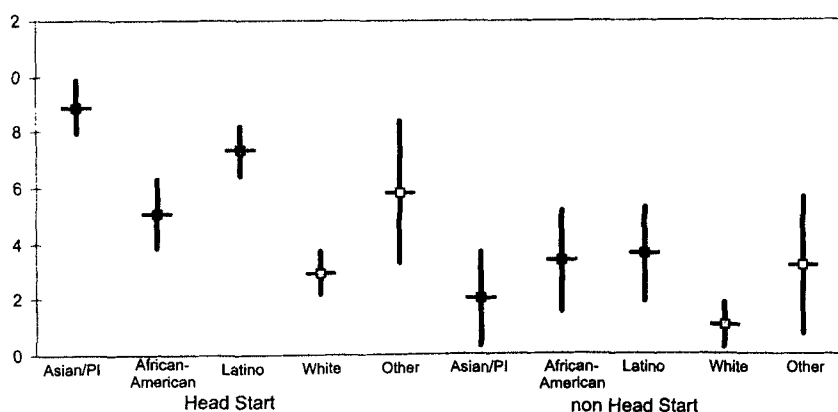
highest prevalence of ECC (main definition) was observed in HS Asians (33%) and HS Latinos/Hispanics (30%), and the lowest prevalence was observed in white children both non-HS (4%) and HS (13%) and in non-HS children in the "other" ethnic subgroup (2%) (Table 3). Among African-American children, the prevalence of ECC was similar in both HS (18%) and non-HS groups (20%). Among non-HS children, African Americans and Latinos/Hispanics had the highest prevalence of ECC and caries in general. When using the broader definition of ECC the prevalence was substantially higher (44% in HS Asians and 39% in HS Latinos/Hispanics). High proportions of untreated ECC (at least two decayed maxillary incisors) were also seen in HS Asians and Latinos/Hispanics, in particular when using the broader definition of ECC. Similarly, more than half of HS Asians and 49 percent of HS Latinos/Hispanics had untreated caries (affecting any teeth). Among whites, one-third of HS children had untreated caries versus only 13 percent among non-HS children. The highest proportion of children with a dmft ≥5 was observed among HS Asians (47%). Among HS children, the percentage of dmft due to decayed teeth was similar in all ethnic groups, ranging from 53 percent to 64 percent. Among non-HS children, the percentage of dmft due to decayed teeth was much higher among Asians (78%) and Latinos (74%) than in other subgroups.

The highest mean dmfs was found among Asian (8.9), Latino (7.3), and African-American (5.1) HS children (Figure 1). The lowest mean dmfs was seen among white non-HS children (1.0). Missing teeth made up a very small part of the dmft and dmfs scores in any of the subgroups.

Multivariable Analyses. When modeling the probability of having ECC (main definition) among California preschool children, we uncovered a statistical interaction between race/ethnicity and HS status. Therefore, our model explores the effect of race/ethnicity in HS and non-HS children separately (Table 4). Among HS children, Asians had the highest odds of having ECC after adjustment for relevant covariates (aOR=3.1; 95% CI=1.5., 6.3) followed by Latinos/Hispanics. Among non-HS children African Americans and Asians were, respectively, 6.3 and 4.3 times more

likely to have ECC than the white reference group. Non-HS Latinos did not appear to be at higher risk for ECC than non-HS whites. There was no statistically significant difference between HS and non-HS whites with respect to odds of having ECC.

The model also suggested that preschool children who had a history of falling asleep while sipping milk or a sweet liquid at age 12 months had a risk of ECC four times higher (95% CI=1.9, 8.5) than the children who did not have such a history. Children aged 5 years or older were significantly more likely to have ECC than children 3 years old or younger. Children whose parent/guardian had graduated from high school had a significantly lower risk of having ECC than those whose parent/guardian did not graduate from high school. Children who were covered by Medi-Cal or private/military dental insurance did not have a lower risk of ECC than those without coverage. Water fluoridation status of the children's area of residence did not have a significant effect on ECC at the 0.1 level of significance in the unadjusted logistic regression analysis , nor was it found to be a confounder of the effect of race/ethnicity on ECC prevalence in the multivariable model. Thus we excluded this covariate from the final logistic regression model.

Discussion

In this large sample of 2,520 California preschool children, we found the largest proportion of children with a history of falling asleep while sipping milk or a sweet substance among Latinos/Hispanics (HS and non-HS) and HS Asians. The highest proportion of parents/guardians without a high school education was also found among HS Latinos/Hispanics and Asians. HS Asians, HS Latinos/Hispanics, and non-HS African Americans had the largest prevalence of ECC and untreated caries. Using multivariable analyses, we also found that among HS children the estimated risk for ECC was highest in Asians and Latinos/Hispanics compared to whites, after controlling for SES variables. Non-HS African-American children had the highest odds of getting ECC compared to non-HS whites. The wide confidence intervals surrounding the aORs suggest a lack of precision of the point estimates that may be

explained by a smaller sample size in the non-HS group. However, another likely explanation for this finding is that the proportion of African-American children whose parents reported an annual household income ≤$19,000 was higher than in the other subgroups. This may be due to the availability of scholarship programs among ethnic minorities to promote diversity in California preschools.

Our prevalence figures for ECC— defined as history of caries in at least two primary maxillary incisors— among HS Asians, HS Latinos/Hispanics, non-HS African Americans were somewhat consistent with other studies using the same definition. One study found ECC in 23 percent of 220 Mexican and Mexican-American children aged 6 years or younger recruited in rural California (24). A survey of 1,230 HS children in five southern states found ECC in 24 percent of Hispanics and 21 percent of blacks (25). The prevalence of untreated caries in various subgroups in our study population was similar to prevalence figures observed among 5,171 preschool children in Arizona (26). These investigators found that among the 4-year-old group in their sample, 55 percent of HS children, 45 percent of blacks, and 57 percent of Hispanics had untreated caries. The prevalence figures of ECC reported in Native American preschool populations in the United States are strikingly higher. They range from 35 percent (25) and 55 percent (27) to more than 60 percent (28,29) when using the definition of caries in at least two primary maxillary incisors. A study using a more stringent definition (at least three primary maxillary incisors with a history of caries) also found that Native American children had a much higher prevalence of the condition than non-Native Americans (25% vs 4%) in HS centers in Alaska (30). Selected populations of Pacific Island and Asian children were found to have a similarly high prevalence of ECC. Among 864 HS children involved in a survey in Micronesia, 36 percent had carious involvement of at least three primary maxillary incisors (8). In his review of nursing caries, Ripa (11) cited a study of 100 children younger than 5 years in Indonesia with 48 percent affected by "bottle caries pattern."

Although some studies have questioned the role of prolonged bottle

feeding as an important etiologic factor for ECC, we found that after controlling for indicators of SES and other relevant variables, children who usually fell asleep while sipping milk or a sweet beverage at age 12 months were four times more likely to have ECC than those who did not. Because the questionnaire was administered prior to the dental examination, it is reasonable to believe that many parents were not aware of their child's dental status, and therefore recall bias is probably not a major issue in this study. Furthermore, a high proportion of parents did not have a high school education and may not have known about the risk of ECC thought to be associated with prolonged bottle feeding.

Even though the multifactorial aspect of the etiology of ECC is now well established (11,12), the question of why its risk of occurrence is higher among some ethnic subgroups while adjusting for SES variables remains unanswered. When considering possible explanations, dietary habits (such as "at-will nursing" in infants and food intake frequency in toddlers) and exposure to cariogenic bacteria may be likely contributing factors. One study in Washington State revealed a strong positive association between the occurrence of caries and the frequency of snacking between meals (three or more times per day) among Native-American children 12 to 36 months of age (31). In addition to high salivary levels of mutans streptococci (MS), which have been found to correlate strongly with high caries experience among various child populations around the world (32-34), there is evidence that MS are transmitted from mother to child (35-37). Therefore, other possible explanatory factors for the high prevalence of ECC among specific ethnic subgroups may be related to cultural practices that promote mother-to-child transmission of cariogenic bacteria. Questions regarding specific practices such as prechewing of food or "cleaning" of the bottle nipple or pacifier in the mother's mouth before placement in the child's mouth should be investigated in studies of ECC.

Our analysis did not appear to be affected by whether or not children lived in an area with fluoridated water. This may be explained by the effect of other sources of topical or systemic fluoride, which would tend

to dilute the effect of water fluoridation. Another possible explanation is that a high proportion of preschool children in the United States and other industrialized countries do not drink much water, which is often substituted by soft drinks or juice. One study in the United Kingdom among 39 preschool children revealed that 72.5 percent never drank water (38). However, it may also be that fluoridation of drinking water does not have a strong protective effect against ECC. A study of 1,230 Head Start children aged 3–5 years in Arkansas, Louisiana, New Mexico, Oklahoma, and Texas found that for rural and nonrural children combined there was a lower prevalence of baby bottle tooth decay in optimally fluoridated areas that was statistically significant. However, when the data were looked at separately in rural and nonrural children, any differences due to fluoridated water were not statistically significant (25). It should be noted, however, that data analysis of the elementary schoolchildren sample from the COHNAC showed that caries experience was statistically significantly lower among lifetime residents of fluoridated areas (39).

This study is unique in that it surveyed a large representative sample of California's diverse preschool child population. The new NIDCR ECC definition could not be strictly applied in our analysis because "white spot lesions" were not assessed as caries in the COHNAC. However, an analysis using dmfs ≥ 1 as definition for ECC, presented by our group at the 2001 meeting of the American Association of Public Health Dentistry, revealed similar findings with respect to estimated risk of ECC by race/ethnicity and HS status (40). Both analyses revealed that in California, HS Asian, HS Latino, and non-HS African-American children had the highest prevalence of ECC and the highest risk of ECC independently of feeding habits at sleep time or socioeconomic status (Medicaid status and parent education). Thus, studies of the cultural/behavioral patterns that may be specific to these subgroups seem essential to the development of effective prevention strategies.

As proposed by many dental public health advocates, a multifactorial prevention strategy is warranted in the fight against ECC (41-43). The use of chemotherapeutic agents such as fluoride or chlorhexidine varnishes, which could be applied by nurses as well as by dental professionals, seems promising (44). Use of chlorhexidine rinses by pregnant mothers in specific subgroups may be another effective strategy to prevent ECC in their offspring. Parental education on ECC should be promoted in the medical care setting through prenatal and postnatal visits by both obstetricians and pediatricians who should receive relevant training with respect to ECC. Dental health education efforts targeted to HS preschools at time of enrollment of each child into the program also may prove to be an effective use of resources. Finally, because some parents may not be aware of their eligibility to Medi-Cal (32% of HS Latino children had no insurance coverage), it may be useful to counsel and educate parents regarding their eligibility for these benefits.

Acknowledgment

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