Prevalence of Early Childhood Caries Among Very Young Urban Boston Children Compared with US Children

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Abstract

Objectives: The aims of this study were to compare prevalence of early childhood caries (ECC) in 1- to 3-year-old children seeing primary-care pediatricians at two urban medical centers in Boston to the prevalence of ECC in similarly aged US children surveyed as part of the Third National Health and Nutrition Examination Survey (NHANES III) and to assess risk factors for ECC among this cohort of children compared with risk factors among similarly aged US children. ***Methods:*** Characteristics of 787 1- to 3-year-old children from two urban Boston medical centers were compared with those of 3,644 similarly aged US children surveyed as part of NHANES III. Demographic and social characteristics and ECC prevalence by putative risk factors were compared. A multiple logistic regression model was fit to assess putative risk factors and difference between groups simultaneously. ***Results:*** Race, age, previous dental visit, parents' education, and household income were significantly associated with ECC prevalence. Parents' place of birth was a significant effect modifier with lower ECC among Boston children of immigrants than among US children of immigrants. ***Conclusions:*** Lower ECC prevalence among urban Boston children of immigrant parents compared with US children of immigrant parents may reflect changing immigrant composition in the United States since NHANES III or a different immigrant composition in the Boston area compared with the United States. This finding reinforces the need for further research of immigrants in order to understand cultural practices that may affect oral health. Finally, low ECC prevalence among very young children reinforces the importance of early intervention in reducing ECC.

Key Words: early childhood caries, oral health disparities

Introduction

Early childhood caries (ECC) is the most common chronic childhood disease (1) and is the most prevalent unmet health need among children in the United States (2,3). Untreated dental disease can result in pain and infection, impair speech, and lead to learning and eating problems (4). According to the 2000 US Surgeon General's report on oral health, over 51 million hours of school are lost each year because of dental disease (5).

Healthy People 2010 has set a target of reducing the proportion of children who have dental caries experience in their primary teeth to 11 percent or less in response to the growing recognition of the negative impact of ECC on quality of life and overall health (1). Although ECC is generally first noted in primary maxillary incisors, it can rapidly spread to primary molars (6) and often leads to dental infection in the permanent dentition (7-10). Because treatment of ECC often requires extensive restorative services that necessitate the use of general anesthesia, treatment of a single case of ECC can cost up to $10,000 (11).

Good prevalence data are lacking because of inconsistent definitions of ECC, the frequent use of specialized, unrepresentative samples (e.g., dental clinic attenders), and the absence of very young children from most study samples (12,13). The available figures, however, clearly demonstrate disparities in prevalence of ECC: poor African-American, Latino, and Native American children have higher ECC prevalence than Caucasian children (14-17). A total of 80 percent of all ECC is experienced by 24 percent of children, primarily from low-income families (3).

Virtually all American children will visit a pediatrician several times by 3 years of age, making pediatricians ideally situated to play a vital role in improving the oral health of children. The American Academy of Pediatrics established a policy in 2003 that every child should receive an oral health assessment (including caries risk assessment) by 6 months of age administered by a qualified pediatrician or pediatric health-care professional (18). Along with identifying general health problems and screening for oral health disease, pediatricians can advise parents on risk factors related to caries formation even before a child's teeth begin to erupt and include anticipatory guidance on oral health-related

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topics at well-child care visits. In addition, a pediatric clinic is an ideal setting for assessing prevalence of ECC and its behavioral risk factors among very young children because virtually all children will visit a pediatrician at some point prior to 3 years of age, while many will not have seen a dentist or dental care professional at this young age.

The purpose of the current study is to estimate ECC prevalence among 1- to 3-year-old children sampled from pediatric clinics in two large urban medical centers and compare ECC prevalence among these children with similarly aged children who were surveyed as part of the Third National Health and Nutritional Examination Survey (NHANES III).

Material and Methods

Study Locations. Children were recruited from two major medical centers in Boston to participate in an ongoing intervention study of ECC, with one center serving as the test site and one center serving as the comparison site. The Boston Medical Center (BMC) pediatric clinic was selected as one site to recruit patients because of its mission to serve underserved populations, including primarily African-American and Latino children. The hospital-based primary care pediatric clinical program at the Floating Hospital for Children is a component of the Tufts-New England Medical Center (NEMC), the other site selected. NEMC is located 1 mi away from BMC and serves a similar urban patient population in regard to socioeconomic status and service to underserved populations, although NEMC sees a larger population of Asian-Americans. Although the clinic populations vary in racial makeup, the clinics are similar in that both serve underserved populations, are both part of large university-based academic medical centers that include pediatric residency training programs, and are located in the same city.

Subjects. Parents/caregivers of 1- to 3-year-old children presenting for well-child visits were asked to participate in the study. Demographic, socioeconomic, and behavioral information were collected from parents/caregivers who agreed to participate in the study. A brief noninvasive clinical examination using a penlight was conducted by a trained, calibrated dental hygienist at each of the two sites to assess the presence or absence of ECC.

For the purpose of this study, only children who were at least 1 year old were included because no information on oral health was available for children younger than 12 months from NHANES III. A total of 787 children, 610 children from BMC and 177 children from NEMC, were included in the current study.

All procedures, including forms for informed consent, for the study involving BMC and NEMC were approved by the respective Institutional Review Boards. Informed consent was obtained from parents or guardians of all children enrolled in the study. All procedures involved in the collection of data for NHANES III were approved by the National Center for Health Statistics Research Ethics Review Board.

NHANES III. NHANES III is a survey conducted by the National Center for Health Statistics from 1988 to 1994 based on a complex, multistage sample plan. It was designed to provide national estimates of the health and nutritional status of the United States' civilian, noninstitutionalized population aged 2 months and older. From 19,528 randomly selected households, 33,994 subjects were interviewed, 30,818 were examined in mobile examination centers, and 493 were examined at home. Examinations were performed by calibrated physicians and dentists, and extensive health, social, and nutritional histories were obtained by interviewing the subjects or their parents. Our analyses were restricted to children at least 1 year of age up to 50 months old, which corresponds to the oldest child sampled from the ECC study described above. All NHANES children included had a record for either nursing bottle caries (applies to children between 12 and 24 months old) or a complete dental examination. A total of 3,644 US children from NHANES III were included for comparison with the children surveyed from two Boston urban medical centers.

Definition of ECC. For the purpose of this study, ECC is defined to be at least one primary maxillary incisor with a cavitated lesion, or a primary maxillary incisor that is missing or filled because of dental caries. White lesions were not considered for this study because they were not recorded in NHANES III. This definition for ECC corresponds to the definition for nursing bottle caries provided for children between 12 and 24 months old in NHANES III.

Statistical Analysis. Weighting was used to obtain population-based estimates of US children surveyed as part of NHANES III. Weights from NHANES III were normalized for the analysis in order to make the two groups more comparable. To make comparisons, children surveyed in the two Boston urban medical centers were grouped together and labeled "urban Boston." Frequency distributions for demographic and social variables were tabulated for both groups, and comparisons were conducted by using the chi-squared test of independence. Means and 95 percent confidence intervals (CIs) were computed for dental variables [the number of primary teeth present, the number of restored teeth, the number of decayed teeth, the number of missing teeth, and number of decayed and filled teeth (dft) score] by group with comparisons conducted by using one-way analysis of variance (ANOVA). In addition to making unadjusted comparisons using one-way ANOVA, one-way analysis of covariance was used to compare dental variables with adjustment for age.

ECC prevalence was tabulated for demographic and social variables with stratification by group. Comparisons of prevalence between urban Boston children and US children for demographic and social variable were conducted by using logistic regression modeling with testing for effect modification.

Table 1
Distribution of Demographic and Social Variables by Group

	Urban Boston (%) $n = 787$	US children (%) $n = 3644$
Gender ($P = 0.837$)		
Male	51.0	50.5
Female	49.0	49.5
Race ($P < 0.001$)		
White	25.0	78.3
Black	66.8	17.4
Other	8.1	4.3
Hispanic ($P = 0.156$)		
Non-Hispanic	85.8	83.7
Hispanic	14.2	16.3
Age group ($P < 0.001$)		
1 year old	57.2	30.5
2 years old	26.2	30.4
3 years old	16.6	39.1
Has the child ever been to the dentist? ($P < 0.001$)		
No	92.6	69.8
Yes	7.4	30.2
Child's health coverage ($P < 0.001$)		
Medicaid	57.1	28.8
Private insurance	26.7	65.0
No Medicaid or insurance	16.3	6.2
Primary language spoken ($P < 0.001$)		
English	48.4	85.8
Spanish	7.4	10.4
Other	44.3	3.8
Child's country of birth ($P = 0.175$)		
United States	96.9	97.7
Other	3.1	2.3
Parents' country of birth ($P < 0.001$)		
United States	37.5	80.2
Other	62.5	19.8
Parents' education ($P < 0.001$)		
Less than high school graduate	15.0	24.2
High school graduate	36.2	33.9
Some college	23.1	19.6
College graduate and beyond	25.7	22.3
Annual household income ($P < 0.001$)		
Less than $20,000	51.1	39.8
$20,000 or More	48.9	60.2

P-values are based on chi-squared test of independence. Weights from Third National Health and Nutrition Examination Survey were normalized.

To evaluate the difference in prevalence between urban Boston children and US children, a multiple logistic regression model was fit that included all putative risk factors that were significant at $\alpha = 0.05$ level of significance. Testing for effect modification was also conducted.

Results

Demographic and Social Variables. The frequency distributions of selected demographic and social variables were tabulated by group and are presented in Table 1. The distribution of urban Boston children did not differ significantly by gender or Hispanic status from children in NHANES III. However, urban Boston children differed in racial composition and age distribution from NHANES III with a significantly greater proportion of black children between the ages 1 and 2 years sampled in the urban Boston area. In addition, urban Boston children were significantly more likely to come from lower-income immigrant households with either no health insurance or only Medicaid than US children as a whole. However, the educational level of the parents/caregivers of Boston children tended to be greater than that of the parents/caregivers of US children. In addition, Boston children were significantly less likely to have visited a dentist or to speak English at home than US children.

Dental Variables. In children at least 2 years of age, summary statistics were calculated for the number of primary teeth present, the number of restored primary teeth, the number of decayed primary teeth, the number of missing primary teeth, and dft score by group (urban Boston children versus US children) and are presented in Table 2. When comparisons were conducted without adjustment for age, US children were found to have significantly more primary teeth, significantly more restored primary teeth, significantly more decayed primary teeth, significantly fewer missing primary teeth, and significantly greater dft score. When comparisons were conducted with adjustment for age, the only statistically significant difference detected was for missing primary teeth, with urban Boston children exhibiting significantly more missing primary teeth than US children do.

ECC Prevalence. Overall ECC prevalence among 1- to 3-year-old urban Boston children was 3.0 percent, while overall ECC prevalence among 1- to 3-year-old US children was 6.3 percent, although this difference was not statistically significant when adjusted for age ($P = 0.158$). ECC prevalence with stratification by group was calculated for selected demographic and social variables and is presented in Table 3. Overall ECC prevalence varied significantly by all demographic and social variables listed except for gender. In particular, greater prevalence of ECC was noted among older children, Hispanic children, children

Table 2
Summary Statistics for Dental Variables by Group (Limited to Children at Least 2 Years of Age)

		Unadjusted model			Adjusted model		
	n	Mean	95% CI	*P**	Mean	95% CI	*P*†
No. of primary teeth							
Urban Boston	336	18.8	18.6 to 19.0	<0.001	19.1	19.0 to 19.3	0.087
US children	2,532	19.4	19.3 to 19.4		19.3	19.2 to 19.3	
No. of restored teeth							
Urban Boston	336	0.00	−0.07 to 0.07	0.024	0.03	−0.04 to 0.11	0.190
US children	2,532	0.09	0.06 to 0.12		0.08	0.06 to 0.11	
No. of decayed teeth							
Urban Boston	336	0.23	0.07 to 0.39	0.009	0.30	0.14 to 0.46	0.122
US children	2,532	0.46	0.40 to 0.51		0.44	0.38 to 0.50	
No. of missing teeth							
Urban Boston	336	0.07	0.04 to 0.09	<0.001	0.07	0.04 to 0.10	<0.001
US children	2,532	0.00	−0.01 to 0.01		0.00	−0.01 to 0.01	
dft Score							
Urban Boston	336	0.23	0.05 to 0.41	0.001	0.33	0.15 to 0.51	0.054
US children	2,532	0.55	0.48 to 0.61		0.52	0.46 to 0.59	
No. of sealants							
Urban Boston	336	0.01	−0.02 to 0.04	0.949	0.01	−0.01 to 0.04	0.793
US children	2,532	0.01	0.00 to 0.02		0.01	0.00 to 0.02	

* *P*-values are based on one-way ANOVA without adjustment for age. Weights from NHANES III were normalized.
† *P*-values are based on one-way ANCOVA with adjustment for age. Weights from NHANES III were normalized.
CI, confidence interval; dft, number of decayed and filled teeth; ANOVA, analysis of variance; ANCOVA, analysis of covariance; NHANES III, Third National Health and Nutrition Examination Survey.

whose race was not white or black, children with a history of a dental visit, children without private health insurance (i.e., those with Medicaid or no health coverage), immigrant children or children of recent immigrants, children of less-educated parents, and children from poor households.

In addition to overall differences in ECC prevalence, significant effect modification was also detected for the difference in ECC prevalence between urban Boston children and US children for the following demographic and social variables: a child's history of visiting the dentist, health coverage type, primary language spoken at home, parents' country of birth, and household income.

Multiple Logistic Regression Analysis of ECC Prevalence. To further evaluate ECC prevalence in very young urban Boston children compared with that in US children, a multiple logistic regression model was fit with adjustment for putative confounding and effect modification with the final model presented in Table 4. Race, age, history of a child's visit to the dentist, parents' education, and annual household income were all significant predictors in the final model. In addition, parents' country of birth was a significant effect modifier. In particular, with adjustment for all confounding, ECC prevalence among urban Boston children whose parents were born in the United States was not significantly different from ECC prevalence among US children whose parents were born in the United States [odds ratio (OR) = 1.10 for US children with parents born in the United States versus urban Boston children with parents born in the United States]. In contrast, US children of immigrant parents were over twice the odds to exhibit ECC compared with US children of parents born in the United States (OR = 2.06; 95 percent CI: 1.47-2.88), whereas urban Boston children of immigrant parents were only half the odds to exhibit ECC compared with urban Boston children of US parents (OR = 0.49; 95 percent CI: 0.35-1.66), although this difference did not achieve statistical significance. In addition, children of immigrants in Boston demonstrated a significantly lower prevalence of ECC than that of children of immigrants throughout the United States, as represented by NHANES III (OR = 0.21, 95 percent CI: 0.08-0.61).

Discussion

When the distributions of demographic and social characteristics of children sampled from two urban Boston medical centers were compared with those of US children, as represented by NHANES III, significant differences were detected, especially with respect to racial composition and socioeconomic characteristics. In addition, although the comparison to US children was limited to those in the same age range, urban Boston children tended to be younger than over half of the children enrolled in the Boston study being under 2 years of age. Of particular note, a significantly greater proportion of urban Boston children was found to be the children of recent immigrants compared with US children, with only 38 percent of parents of urban Boston children

Table 3
Distribution of Early Childhood Caries Prevalence by Group with Stratification by Demographic and Social Variables

	Urban Boston (%) $n = 787$	US children (%) $n = 3{,}644$
Gender ($P = 0.765$)		
Male	3.0	5.8
Female	3.1	6.8
Race ($P = 0.181$)		
White	3.6	5.2
Black	2.7	8.3
Other	4.7	17.9
Hispanic ($P = 0.438$)		
Non-Hispanic	2.8	5.2
Hispanic	4.5	11.8
Age group ($P = 0.097$)		
1 year old	1.3	1.0
2 years old	6.3	6.5
3 years old	3.8	10.3
Has child ever been to the dentist? ($P = 0.006$)		
No	1.7	7.6
Yes	11.6	10.9
Child's health coverage ($P = 0.045$)		
Medicaid	2.7	11.1
Private insurance	2.9	3.6
No medicaid or insurance	4.7	9.7
Primary language spoken ($P < 0.001$)		
English	4.0	5.0
Spanish	3.5	12.4
Other	2.0	19.4
Child's country of birth ($P = 0.971$)		
United States	3.2	6.0
Other	0.0	20.7
Parents' country of birth ($P < 0.001$)		
United States	4.4	4.9
Other	2.3	12.3
Parents' education ($P = 0.204$)		
Less than high school graduate	5.2	11.9
High school graduate	2.9	6.6
Some college	3.9	3.1
College graduate and beyond	1.5	2.1
Annual household income ($P = 0.012$)		
Less than $20,000	3.0	10.6
$20,000 or More	3.1	3.4

P-values are based on test for effect modification in logistic regression model comparing US children to urban Boston children. Weights from the Third National Health and Nutrition Examination Survey were normalized.

born in the United States compared with 80 percent of parents of US children. In addition, urban Boston children were much less likely to have private health insurance than their US counterparts, with only 27 percent of urban Boston children covered by private health insurance compared with 65 percent of US children.

Significant differences in dental variables between urban Boston children and US children were detected when comparisons were made without adjustment. However, when adjustment was made for age, the only significant difference detected was for missing teeth, with urban Boston children having significantly more missing teeth than US children do. One reason for this difference may be misclassification because unerupted teeth may have inadvertently been recorded as missing.

Differences in the prevalence of ECC among urban Boston children compared with US children were detected for a child's history of visiting the dentist, the child's type of health coverage, primary language spoken at home, parents' country of birth, and household income. In particular, the prevalence of ECC among urban Boston children whose primary language was not English did not vary significantly from urban Boston children whose primary language was English (OR = 0.55, $P = 0.166$), nor did the prevalence of ECC among urban Boston children of foreign-born parents vary significantly from urban Boston children of United States-born parents (OR = 0.50, $P = 0.093$). This is in contrast to ECC prevalence of US children of foreign-born parents who had almost three times the odds of having ECC compared to US children of United States-born parents (OR = 2.7, $P < 0.001$). Similarly, the odds of ECC among US children whose primary language spoken at home was not English were over three times the odds of ECC of US children whose primary language spoken at home was English (OR = 3.2, $P < 0.001$). These differences between urban Boston children surveyed for the current study and US children, as represented by NHANES III, would seem to indicate significant differences in the characteristics of immigrants in the urban Boston area compared with immigrants throughout the United States.

Another characteristic where the ECC prevalence among urban Boston children varies significantly from US children is health insurance coverage. Urban Boston children without health insurance or who were on Medicaid were not significantly more likely to have ECC than urban Boston children with private health insurance (OR = 1.1, $P = 0.851$). In contrast, US children without health insurance or who were on Medicaid were over three

Table 4
Multiple Logistic Regression for Early Childhood Caries

	Odds ratio	95% confidence interval
Race		
White	1.00	
Black	1.28	(0.89, 1.85)
Other	2.97	(1.77, 4.99)
Age group		
1 year old	1.00	
2 years old	3.26	(0.83, 12.7)
3 years old	4.30	(1.10, 16.9)
Has child ever been to the dentist?		
No	1.00	
Yes	1.99	(1.44, 2.76)
Parents' education		
Less than high school graduate	1.00	
High school graduate	0.71	(0.50, 0.99)
Some college	0.36	(0.22, 0.59)
College graduate and beyond	0.22	(0.12, 0.41)
Annual household income		
Less than $20,000	1.00	
$20,000 or more	0.48	(0.34, 0.68)
Group and parents' country of birth		
Urban Boston and US birthplace	1.00	
Urban Boston and foreign birthplace	0.49	(0.35, 1.66)
US children and US birthplace	1.10	(0.42, 2.88)
US children and foreign birthplace	2.27	(0.85, 6.10)

times more likely to have ECC than US children with private health insurance ($OR = 3.3$, $P < 0.001$). One reason for this difference in ECC prevalence may be the larger proportion of very young children in the sample of urban Boston children compared with US children sampled for NHANES III where the distribution was evenly divided among the age groups under investigation. This contention is supported by an increased prevalence of ECC that was noted for the more comprehensive definition of ECC that included both white lesions and cavitated lesions in our other work that described ECC prevalence in the BMC and the New England Medical Center Floating Hospital ($OR = 2.02$, $P = 0.035$). White lesions were not included in the current study because the operational definition of dental caries for NHANES III did not include white lesions. In other words, without intervention, the majority of these very young children with only white lesions would be expected to eventually develop cavitated lesions as they get older, which would then reflect the increased ECC prevalence among children with limited access to health care noted for US children.

When all putative risk factors were considered simultaneously, race, age group, a child's previous visit to the dentist, the educational level of the parents, annual household income, and US children of foreign-born parents were all found to be associated with ECC. Children whose race was other than black or white had a significantly higher prevalence of ECC than either white or black children. These results correspond to increased prevalence of ECC among Asian and Hispanic children compared with White and Black children reported by Shiboski *et al.* (17) Older children were also more likely to have ECC, as expected from the increased exposure of teeth in the oral cavity over time. Children who had previously visited the dentist were also more likely to have ECC, which supports a study by Huntington *et al.* (19), who noted a significantly greater prevalence of ECC among Hispanic children who had previously visited the dentist. Among these very young children, a history of visiting the dentist is likely related to a child's having already encountered dental problems as opposed to parents seeking preventive care for their children. Educational level of parents was also a significant risk factor for ECC with a greater prevalence of ECC noted among children of less-educated parents, which is consistent with a study by Schroth and Moffatt (20) that reported a higher prevalence of ECC among children under 3 years of age with poorly educated mothers. Low income was also associated with increased odds of ECC, which is consistent with a study by Hallett and O'Rourke (21), who reported higher prevalence of ECC among lower-income households.

A particularly interesting finding from the multiple logistic regression analysis was the difference in ECC prevalence among urban Boston children of foreign-born parents compared with ECC prevalence among US children of foreign-born parents. This difference may reflect the different composition of immigrants in the Boston area compared with immigrants throughout the United States. According to a study by Cote *et al.* (22), the caries experience of refugee children examined in the Boston area varied significantly by region of origin, with African children demonstrating significantly less caries experience than either children from Eastern Europe or US children. Reduced prevalence of ECC among children of foreign-born parents may reflect a greater concentration of these African refugees into the urban Boston population than of immigrants throughout the United States, as represented by NHANES III. In addition, following war in Somalia, Rwanda, and other areas of Africa, there is likely a much greater number of recent immigrants from Africa since NHANES III was conducted. Hence, the lower ECC prevalence associated with urban Boston children of foreign-born parents may also reflect the changing composition of immigrants into the United States since NHANES III was conducted.

Conclusions

When evaluated simultaneously, race, age, a child's previous dental visit, parents' educational level, and annual household income were all significantly associated with ECC prevalence in both samples. However, ECC prevalence among urban Boston children of foreign-born parents was significantly lower than ECC prevalence among US children of foreign-born parents. Lower ECC prevalence among urban Boston children of foreign-born parents may reflect the changing composition of immigrants into the United States since NHANES III was conducted or a different composition of immigrants in the Boston area compared with the United States as a whole. This finding reinforces the need for further research of immigrants in order to better understand positive and negative cultural factors and practices that may affect oral health. Finally, the low ECC prevalence noted among very young urban Boston children reinforces the role that primary care pediatricians and other pediatric health-care professionals may play in preventing ECC through early detection and intervention.

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