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ARTICLE

Association Between Infant Breastfeeding and Early Childhood Caries in the United States

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ABSTRACT

OBJECTIVE. Despite limited epidemiologic evidence, concern has been raised that breastfeeding and its duration may increase the risk of early childhood caries. The objective of this study was to assess the potential association of breastfeeding and other factors with the risk for early childhood caries among young children in the United States.

METHODS. Data about oral health, infant feeding, and other child and family characteristics among children 2 to 5 years of age ($N = 1576$) were extracted from the 1999–2002 National Health and Nutrition Examination Survey. The association of breastfeeding and its duration, as well as other factors that previous research has found associated with early childhood caries, was examined in bivariate analyses and by multivariable logistic and Poisson regression analyses.

RESULTS. After adjusting for potential confounders significant in bivariate analyses, breastfeeding and its duration were not associated with the risk for early childhood caries. Independent associations with increased risk for early childhood caries were older child age, poverty, being Mexican American, a dental visit within the last year, and maternal prenatal smoking. Poverty and being Mexican American also were independently associated with severe early childhood caries, whereas characteristics that were independently associated with greater decayed and filled surfaces on primary teeth surfaces were poverty, a dental visit within the last year, 5 years of age, and maternal smoking.

CONCLUSIONS. These data provide no evidence to suggest that breastfeeding or its duration are independent risk factors for early childhood caries, severe early childhood caries, or decayed and filled surfaces on primary teeth. In contrast, they identify poverty, Mexican American ethnic status, and maternal smoking as independent risk factors for early childhood caries, which highlights the need to target poor and Mexican American children and those whose mothers smoke for early preventive dental visits.

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Key Words
breastfeeding, early childhood caries, maternal smoking

Abbreviations
ECC— early childhood caries
S-ECC—severe early childhood caries
NHANES—National Health and Nutrition Examination Survey
dfs— decayed and filled surfaces on primary teeth
aOR—adjusted odds ratio
CI— confidence interval
IDR—incidence density ratio
FPL—federal poverty level

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The American Academy of Pediatrics identifies human milk as the ideal nutrient for infants[1] on the basis of the extensive scientific evidence demonstrating that breastfeeding and the use of human milk provide multiple health-related advantages to infants, mothers, and society.[1,2] Breastfeeding is recommended by pediatricians and other health care professionals to be continued for at least the first year of life and beyond, for as long as mutually desired by mother and child.[1] Prolonged and unrestricted breastfeeding, however, has been reported to be a potential risk factor for early childhood caries (ECC),[3–6] and a recent animal study, the results of which were recently published in this journal, found breast milk to be more cariogenic than bovine milk.[7] However, epidemiologic evidence linking infant breastfeeding and its duration and ECC in children is very limited. The purpose of this study was to use nationally representative data about children to assess the potential association of breastfeeding and its duration, as well as the association of other factors that there is reason to believe may contribute to ECC, with the risk for ECC among young children in the United States.

MATERIALS AND METHODS

Data from the 1999–2002 National Health and Nutrition Examination Survey (NHANES),[8] a cross-sectional survey conducted by the National Center for Health Statistics, Centers for Disease Control and Prevention, were analyzed for 1576 children 2 to 5 years of age with information on both infant feeding and oral health. The NHANES includes a household interview with information regarding numerous aspects of children's diet, nutrition and oral health behavior, and family socioeconomic characteristics completed by the person most knowledgeable about the child, usually the mother. Results of dental examinations also are included as part of this survey.

Infant Breastfeeding Data

Information about infant feeding was obtained from parents/guardians of children during an in-person interview based on retrospective recall. The definition of the various breastfeeding categories used in this study was based on the schema developed by the Interagency Group for Action on Breastfeeding in 1988.[9] Breastfeeding and its duration (overall, full, and exclusive) were examined by using the following criteria: whether the child was ever breastfed (history of breastfeeding), the age when the child completely stopped breastfeeding or being fed breast milk (overall breastfeeding duration), the age when the child was first fed something other than breast milk or water (exclusive breastfeeding duration), and the age when the child was first fed formula, milk, or solid foods on a daily basis (full breastfeeding duration). Children who consumed only breast milk, with or without the consumption of water, were included in the assessment of exclusive breastfeeding duration although, most conservatively, exclusive breastfeeding often refers to the period when infants do not consume anything other than breast milk. This decision was based on limitations of the NHANES data and the fact that there are no data to suggest that the consumption of water is a risk factor for dental caries.

ECC, Severe ECC, and Decayed or Filled Primary Tooth Surfaces Count Data

A dental examination was performed for children aged ≥2 years by a trained and calibrated dentist in a medical examination center. Dental caries, that is, decayed or filled primary tooth surfaces (dfs), was assessed by means of a visual/tactile examination without radiographs.[10] The American Academy of Pediatric Dentistry defines ECC and severe ECC (S-ECC) as follows[11]: ECC is the presence of ≥1 decayed, missing (because of caries), or filled primary tooth surfaces (dmfs) in any primary tooth in a child ≤71 months of age. S-ECC is defined as any sign of smooth-surface caries in children <3 years of age; ≥1 cavitated, missing (because of caries), or filled smooth surface in primary maxillary anterior teeth from ages 3 through 5 years; or the presence of ≥1 decayed, missing (because of caries), or filled primary tooth surfaces of ≥4 at age 3 years, ≥5 at age 4 years, or ≥6 at age 5 years. The reasons for missing primary teeth were not identified in the NHANES data. Hence, in this study, ECC refers to the presence of any dfs on any primary tooth and S-ECC refers to the presence of dfs on any maxillary incisor in children 2 to 5 years of age. The total dfs count was used as a measure of disease severity.

Other Variables Investigated

Other potential associations with ECC, S-ECC, and dfs count were analyzed, including birth weight, age, gender, race/ethnicity, poverty status, maternal age at child's birth, maternal history of smoking during pregnancy, history of admission to a NICU, and time since last dental visit. Information about these factors was obtained through the household interview. As discussed further in "Discussion," each of these factors was included because of previous research indicating their association with dental caries or breastfeeding.[12–17]

Statistical Analyses

The prevalence of children with ECC, S-ECC, and mean dfs count was calculated to assess the association of caries with the history and duration of breastfeeding (overall, full, and exclusive) and selected other factors. χ^2 tests, t tests, and analyses of variance were performed to assess statistical significance. Logistic regression models were performed with the outcomes of ECC and S-ECC (any versus none) to assess the independent association of breastfeeding while controlling for potential confounders found in the bivariate (unadjusted) analy-

ses ($P \leq .10$). Similarly, Poisson regression models were analyzed with dfs count as the outcome. Adjusted odds ratios (aORs) and incidence density ratios (IDRs) were calculated for each, respectively. The IDR is the ratio of the incidence rate among exposed to that of unexposed children. An IDR of unity indicates that a covariate is not associated with the dependent variable (dfs count). All of the potential confounders included in the models were categorical variables; therefore, each AOR and IDR compares the association of a particular category to a reference category for each covariate. Interactions with breastfeeding were included in secondary analyses; however, results are based on the models with only the main effects. Because the NHANES uses a complex, multistage sampling design, SUDAAN software (Research Triangle Institute, Research Triangle Park, NC)[18] was used to estimate appropriate variances for all of the analyses, including bivariate analyses and multivariable logistic and Poisson regressions.[19] Results were weighted to be representative of 2- to 5-year-olds in the United States according to the sampling weights that are provided by the NHANES.[19]

RESULTS

Not shown in the tables are the following findings about sociodemographic characteristics of children according to breastfeeding category: children reported to have been breastfed were more likely to be nonblack, living at or above 200% of the federal poverty level (FPL), and born to older mothers who were less likely to report smoking during pregnancy ($P < .001$ for each). Those exclusively breastfed for ≥9 months were more likely to be normal birth weight and Mexican American, whereas children who were breastfed overall for a year or longer were more likely to be Mexican American and born to mothers who did not smoke during pregnancy ($P < .05$ for each). The majority of breastfed children (~75%) were introduced to something other than breast milk or water by age 3 to 6 months.

Sample characteristics and the results of bivariate analyses are shown in Table 1. Overall, 27.5% of 2- to 5-year-old-children had ECC (any dfs), and 10% had S-ECC (any dfs on maxillary incisors). Approximately 60% of children were reported as having ever been breastfed, and overall such children had lower rates of ECC and S-ECC compared with those never breastfed. Children breastfed overall for ≥1 year were more likely to experience ECC than children who were breastfed for <1 year (32.8% vs 22.5%; $P < .01$; data not shown in tables), whereas there was no statistically significant difference in rates of ECC between those exclusively breastfed for ≥9 months compared with those exclusively breastfed for <9 months (19.5% vs 25.4%; $P = .36$; data not shown in tables).

ECC rates increased with age, whereas S-ECC rates did not. Family income and child race/ethnicity both were associated with ECC and S-ECC, with rates of both highest among those living below the FPL and lowest among those living at ≥200% of the FPL. Mexican American children had the highest rates of both ECC and S-ECC, followed by non-Hispanic black children and non-Hispanic white children, with children of other race/ethnicities having the lowest rates. Prenatal maternal smoking was associated with increased rates of ECC but not with rates of S-ECC. Overall, 36.3% of children who had a dental visit in the last year had ECC, whereas the percentage of children who had ECC and did not have a dental visit within the last year was only 18.5%.

In logistic regression analyses conducted to identify factors independently associated with ECC (Table 2), a history of ever having been breastfed was not associated with rates of ECC. In contrast, independent risks for ECC were increased child age, Mexican American ethnicity, living below the FPL, maternal prenatal smoking, and having had a dental visit within the last year.

Factors independently associated with an increased risk for S-ECC are shown in Table 3 and include Mexican American ethnicity and living at <200% of the FPL, whereas a history of ever having been breastfed was not associated with rates of S-ECC. Table 4 shows results of multivariable analyses that demonstrate that breastfeeding duration, whether overall, full, or exclusive, is not associated with either reduced or increased risk of ECC or S-ECC.

Overall, the mean dfs count was 2.4. Poisson regression models that included the child's birth weight, age, race/ethnicity, poverty status, maternal age at child's birth, maternal smoking during pregnancy, and time since last dental visit were used to assess the association between infant breastfeeding and dfs counts (Table 5). History of breastfeeding or breastfeeding duration of any type again were not significantly associated with DFS counts, whereas being 5 years old, living below the FPL, maternal smoking during pregnancy, and having a dental visit in the past year each were independently associated with increased dfs counts. Children's birth weight, race/ethnicity, and maternal age at child's birth were not associated with increased numbers of caries.

Additional regression analyses were performed to attempt to better explicate the relationships between breastfeeding status and other factors investigated for associations with ECC, as well as for interaction effects. Breastfeeding was associated with a 40% reduced risk for ECC (aOR: 0.6; 95% confidence interval [CI]: 0.4–0.9; data not shown in tables) when poverty status, maternal age at child's birth, and maternal prenatal smoking were excluded from the full model used in Table 2 and similarly was associated with a 40% decrease in the risk for S-ECC (aOR: 0.6; 95% CI: 0.4–0.9; data not shown in tables) when poverty status and maternal age at child's birth were removed from the full model used in Table 3. When accounting for interactions

TABLE 1 **Distribution of US Children Aged 2 to 5 Years by Study Variables for ECC and S-ECC (Unadjusted Analysis)**

Variable	ECC			S-ECC		
	Sample Size	Prevalence, %	*P*	Sample Size	Prevalence, %	*P*
Overall	1576	27.5		1503	10.0	
History of breastfeeding	1568		.03	1495		.02
Ever	939	24.9		899	8.2	
Never	629	32.3		596	13.5	
Overall breastfeeding duration	1562		.01	1489		.02
≥1 y	216	32.8		210	11.9	
6 mo to <1 y	274	20.6		265	5.4	
4 to <6 mo	105	24.9		97	9.6	
1 to <4 mo	233	22.2		222	6.0	
<1 mo	105	26.6		99	11.6	
0	629	32.3		596	13.5	
Exclusive breastfeeding duration, mo	1561		.054	1488		.049
≥9	57	19.5		55	7.2	
6 to <9	166	29.5		160	8.5	
3 to <6	311	23.6		299	6.9	
<3	398	24.8		378	9.3	
0	629	32.3		596	13.5	
Full breastfeeding duration, mo	1562		.04	1489		.03
≥9	55	25.5		53	9.6	
6 to <9	179	27.2		174	7.5	
3 to <6	304	24.8		286	6.4	
<3	395	23.8		380	9.8	
0	629	32.3		596	13.5	
Birth weight, g	1517		.63	1448		.02
Very low (<1500)	24	17.3		23	2.2	
Low (1500–2499)	124	29.2		118	9.1	
Normal (≥2500)	1369	27.6		1307	10.1	
Age, y			<.001			.22
2	495	10.9		487	7.6	
3	381	20.9		370	10.1	
4	362	34.4		347	10.8	
5	338	44.3		299	11.7	
Gender			.49			.99
Male	793	28.7		751	10.0	
Female	783	26.3		752	10.0	
Race/ethnicity			<.001			<.001
Non-Hispanic white	489	25.3		477	7.9	
Non-Hispanic black	456	31.8		427	13.9	
Mexican American	478	41.9		458	17.9	
Other	153	17.3		141	7.2	
Poverty status, % FPL	1408		<.001	1342		<.001
<100	511	41.3		478	18.6	
100 to <200	395	27.9		377	11.2	
≥200	502	17.2		487	4.4	
Maternal age at child's birth, y	1570		<.001	1498		.01
≤19	253	38.5		237	18.5	
20–29	839	29.3		804	10.1	
≥30	478	21.6		457	7.4	
Maternal smoking during pregnancy	1563		.01	1491		.21
Yes	226	38.4		217	14.1	
No	1337	25.3		1274	9.1	
NICU	1568		.73	1495		.29
Yes	175	28.7		165	13.2	
No	1393	27.3		1330	9.4	
Time since last dental visit	1508		<.001	1445		.26
≤1 y	672	36.3		619	11.3	
>1 y	836	18.5		826	8.6	

ECC includes any DFS score (≥1), and S-ECC includes any DFS score (≥1) on maxillary incisors.
Source: NHANES, 1999–2002.[8]

TABLE 2 **Multivariable Logistic Regression Model for ECC: US Children Aged 2 to 5 Years ($N = 1302$)**

Independent Variables	aOR	95% CI	*P*
History of breastfeeding			
Ever	0.97	0.63–1.49	.89
Never	1.00	NA	NA
Birth weight			
Very low and low	0.66	0.36–1.19	.16
Normal	1.00	NA	NA
Age, y			
2	1.00	NA	NA
3	1.83	1.16–2.88	.01
4	3.22	1.84–5.63	<.001
5	4.77	2.63–8.66	<.001
Race/ethnicity			
Non-Hispanic white	1.00	NA	NA
Non-Hispanic black	0.95	0.64–1.41	.79
Mexican American	1.85	1.33–2.57	.001
Other	0.60	0.31–1.19	.14
Poverty status, % FPL			
<100	3.45	2.05–5.81	<.001
100 to <200	1.72	0.99–2.99	.06
≥200	1.00	NA	NA
Maternal age at child's birth, y			
≤19	1.51	0.90–2.54	.11
20–29	1.05	0.69–1.59	.81
≥30	1.00	NA	NA
Maternal smoking during pregnancy			
Yes	1.68	1.01–2.79	.05
No	1.00	NA	NA
Time since last dental visit, y			
≤1	1.84	1.15–2.95	.01
>1	1.00	NA	NA

ECC is for any DFS (≥1). NA indicates not applicable.
Source: NHANES, 1999–2002.[8]

TABLE 3 **Multivariate Logistic Regression Model for S-ECC: US Children Aged 2 to 5 Years ($N = 1298$)**

Independent Variables	aOR	95% CI	*P*
History of breastfeeding			
Ever	0.83	0.49–1.40	.47
Never	1.00	NA	NA
Birth weight			
Very low and low	0.52	0.25–1.10	.09
Normal	1.00	NA	NA
Race/ethnicity			
Non-Hispanic white	1.00	NA	NA
Non-Hispanic black	1.02	0.55–1.87	.96
Mexican American	1.84	1.08–3.14	.03
Other	0.87	0.36–2.15	.76
Poverty status, % FPL			
<100	4.14	2.03–8.42	<.001
100 to <200	2.26	1.21–4.22	.01
≥200	1.00	NA	NA
Maternal age at child's birth, y			
≤19	1.48	0.64–3.43	.35
20–29	0.93	0.47–1.82	.82
≥30	1.00	NA	NA

S-ECC is for any DFS (≥1) on maxillary incisors. NA indicates not applicable.
Source: NHANES, 1999–2002.[8]

of breastfeeding and other factors included in the full model, breastfed Mexican American children were at greater risk for ECC than non-Hispanic white children who were never breastfed (aOR: 2.1; 95% CI: 1.1–3.8), and breastfed children living below the FPL were also more likely to experience ECC than children living in families at ≥200% of the FPL who had never been breastfed (aOR: 3.2; 95% CI: 1.4–7.3).

DISCUSSION

Although Bowen and Lawrence,[7] using a desalivated rat model, reported recently that human breast milk was more cariogenic than bovine milk, epidemiologic data on breastfeeding and caries risk are quite limited. Breastfeeding and dental caries among children aged 2 through 5 years was studied previously using data from 1988 to 1994, and no association was found.[16] In the current study, using more recent data and more detailed categorization of breastfeeding duration and type, the potential association of the duration of exclusive breastfeeding and breastfeeding accompanied by additional supplemental feedings that potentially contained sucrose were investigated. The findings indicate that infant breastfeeding and its duration, whether overall, full, or exclusive, is not associated with any increased risk for ECC or S-ECC. In contrast, poverty, Mexican American ethnic status, and maternal smoking during pregnancy were each found to be independently associated with ECC. Several previous studies reported findings similar to those reported in this article concerning the association between various aspects of breastfeeding and ECC.[20–23] Although breastfeeding was not found to be associated with either an increased or decreased risk of ECC, decreased family income and prenatal maternal smoking, both strongly associated with decreased rates of breastfeeding as demonstrated in previous studies,[12] were both found to be independently associated with an increased risk.

Maternal smoking during pregnancy is well recognized to be associated with myriad negative perinatal health outcomes in children,[24–27] in addition to early termination of breastfeeding.[28,29] In this study, children whose mothers reported smoking during pregnancy were less likely to be breastfed, but maternal smoking during pregnancy also was independently associated with increased rates of ECC and higher numbers of caries in multivariable analyses that controlled for breastfeeding. It is not possible from these data to disentangle whether it is prenatal, postnatal, or both prenatal and postnatal tobacco smoke exposure that is associated with an increased risk of ECC, because women who smoke during pregnancy are likely to continue smoking postnatally. Also, whereas it is possible that maternal smoking during pregnancy may simply be a marker for a mother's unhealthy choices for diet and oral hygiene practices, the association between secondhand tobacco smoke exposure and increased risk for dental caries in children in this and previous studies[17,30,31] indicates a

TABLE 4 **aORs for Types of Breastfeeding and Its Duration Associated With the Risk of ECC and S-ECC: US Children Aged 2 to 5 Years**

Breastfeeding Types and Duration	aOR for ECC	95% CI	aOR for S-ECC	95% CI
Overall breastfeeding duration ($N = 1299$)				
≥1 y	1.43	0.83–2.48	1.18	0.59–2.34
6 mo to <1 y	0.80	0.42–1.56	0.62	0.30–1.28
4 to <6 mo	0.94	0.42–2.11	0.92	0.29–2.91
1 to <4 mo	0.83	0.49–1.41	0.57	0.30–1.09
<1 mo	0.95	0.54–1.67	1.20	0.54–2.66
0	1.00	NA	1.00	NA
Exclusive breastfeeding duration ($N = 1298$), mo				
≥9	0.68	0.28–1.67	0.74	0.30–1.84
6 to <9	1.23	0.62–2.43	0.89	0.36–2.17
3 to <6	0.96	0.51–1.80	0.68	0.40–1.13
<3	0.91	0.62–1.33	0.97	0.50–1.91
0	1.00	NA	1.00	NA
Full breastfeeding duration ($N = 1299$), mo				
≥9	1.14	0.43–3.01	1.13	0.44–2.87
6 to <9	1.04	0.55–1.99	0.80	0.34–1.88
3 to <6	0.97	0.55–1.72	0.62	0.36–1.08
<3	0.91	0.62–1.33	1.00	0.52–1.93
0	1.00	NA	1.00	NA

ECC is for any DFS (≥1). S-ECC is for any DFS (≥1) on maxillary incisors. NA indicates not applicable.
Source: NHANES, 1999–2002.[8]

TABLE 5 **Poisson Regression for DFS Count: US Children Aged 2 to 5 Years ($N = 1302$)**

Independent Variables	IDR	95% IDR	*P*
History of breastfeeding			
Ever	1.18	0.75–1.86	.47
Never	1.00	NA	NA
Birth weight			
Very low and low	1.45	0.63–3.31	.99
Normal	1.00	NA	NA
Age, y			
2	1.00	NA	NA
3	1.34	0.70–2.59	.37
4	1.37	0.77–2.44	.27
5	2.09	1.17–3.73	.01
Race/ethnicity			
Non-Hispanic white	1.00	NA	NA
Non-Hispanic black	0.68	0.42–1.08	.10
Mexican American	1.14	0.70–1.84	.59
Other	0.74	0.35–1.58	.42
Poverty status, % FPL			
<100	5.12	2.85–9.18	<.001
100 to <200	1.82	0.91–3.63	.09
≥200	1.00	NA	NA
Maternal age at child's birth, y			
≤19	1.17	0.67–2.03	0.58
20–29	0.56	0.54–1.45	0.61
≥30	1.00	NA	NA
Maternal smoking during pregnancy			
Yes	1.54	1.06–2.24	0.02
No	1.00	NA	NA
Time since last dental visit, y			
≤1	3.92	2.55–6.01	<0.001
>1	1.00	NA	NA

Source: NHANES, 1999–2002.[8]

clear need to establish the possible causal nature of the association of exposures to maternal smoking in utero and postnatally and ECC.

Consistent with previous studies, children living in poverty and Mexican American children were at significantly increased risk for both ECC and S-ECC.[13,16,32] Although it is well recognized that socioeconomic factors and ethnicity influence dietary and oral health-related behaviors, as well as access to dental care, it remains unclear why poor and Mexican American children are at increased risk for ECC. Mexican American children in this nationally representative sample were more likely to breastfeed longer (both overall and exclusively) than other ethnic/racial groups. Ramos-Gomez et al[21] found higher rates of ECC among Mexican-American rural migrant children in California, but nursing patterns, such as duration, frequency or bedtime bottle/breastfeeding were not found to be independently associated with increased rates. Interestingly, in the current study, breastfed Mexican American and breastfed poor children had higher rates of ECC than non–Mexican American children or those living at ≥200% of the FPL who were never breastfed. The reasons for this could not be investigated because of limitations of the data. The NHANES 1999–2002 lacks, for example, information about nursing patterns, as well as other potentially cariogenic factors that might have been associated with poverty or being Mexican American, such as the level of oral cariogenic microorganisms, frequency of carbohydrate intake, or personal oral hygiene habits. These findings do suggest, however, that breastfeeding does not eradicate the increased risk for ECC among Mexican American children and those living in poverty.

The American Academy of Pediatric Dentistry currently recommends weaning from bottle or breastfeeding by the age of 12 to 14 months and discourages bedtime infant feeding, especially after the eruption of

the first tooth, to prevent ECC.[33] Although Roberts et al,[23] in their study of 1- to 4-year-old South African children, reported that children who were breastfed for ≥12 months had a lower level of caries than those bottle fed or bottle and breastfed for <12 months, the current study provides no evidence that breastfeeding for >1 year decreases or increases the risk for ECC or dfs counts. Moreover, interpretation of the results of the current study relevant to this issue is further limited in a number of ways. For example, the quantity and quality of supplemental feedings, the quantity of breastfeeding, and information about other factors, such as bedtime breastfeeding or bottle feeding, are not available from NHANES data, and, thus, it is not known how these factors might differ among those breastfed for >1 year and those breastfed for a shorter duration. Several other studies have investigated these factors; however, the results of such studies remain inconclusive.[5,6,16,34,35]

It has been found previously that infrequent dental visits were associated with an increased risk for untreated caries.[16,30] In the current study, however, children who had a dental visit within the last year had higher ECC rates and were at significant risk for greater dfs counts than children who did not visit a dentist in the last year. Graves et al[36] also reported a positive relation between the number of dental visits and caries prevalence in children. Vargas et al[37] examined the relationship between children's dental needs and dental care use and reported that young children 2 to 5 years of age without perceived needs were more likely to have never visited a dentist than those with perceived needs. They also found that 42% of parents of 3- to 4-year-old children attending Head Start in Maryland reported that their child had not been to the dentist because he or she was too young to visit the dentist, and 29% of parents reported that their child did not have dental problems.[38] In addition to such parental misconceptions about dental visits for preschool-aged children, what could attribute to limited access for timely and regular preventive dental care for children during early childhood includes the absence of successful referrals from pediatric care professionals for primary dental care and an insufficient dental capacity, because a low number of dentists accept infants, toddlers, and Medicaid insurance nationwide.[39] We postulate that most young children's dental visits are currently driven by existing dental problems in children and their urgency for care rather than routine dental prevention, and the relationship between caries and dental visits found in this study is a reflection of children's need for dental treatment.

Age-related accumulation of caries among children is well recognized,[13] and this finding was corroborated in this study. S-ECC prevalence, however, was not found to be associated with age. It is possible that S-ECC teeth that were naturally exfoliated or extracted before subjects' participation in the NHANES might have contributed to this and led us to erroneously find no age-related increases in S-ECC. O'Sullivan and Tinanoff, however,[40] have suggested that the prevalence of the maxillary anterior pattern of ECC usually does not increase after the age of 3 years, because children who are at risk will already have manifested the disease, and most children will have discontinued inappropriate bottle habits by age 3 years. Although their suggestion is based on the association between poor bottle habits and caries risk, bivariate analyses of data measured in the present study indicate that the prevalence of S-ECC was fairly stable among children ≥3 years of age. Because primary maxillary incisors usually erupt by age 1 year and can manifest nursing caries earlier than any other teeth if deleterious oral habits exist from birth,[41] further studies should include children younger than age 2 years so we can obtain a clearer picture of risk factors for S-ECC.

A major strength of this study is its large, nationally representative sample of US children who are ethnically diverse. Limitations, in addition to those already noted, include the use of cross-sectional data to examine possible relationships between previous breastfeeding experiences and caries or filled-tooth surfaces at the time of the survey, introducing the potential for recall bias of the estimation of breastfeeding duration and introduction of other foods. Ruowei et al[42] reported that validity and reliability of maternal recall for the age at introduction of foods and fluids other than breast milk are less satisfactory than for initiation and termination of breastfeeding. Thus, the information on exclusive and full breastfeeding duration may be more affected by retrospective recall bias than overall breastfeeding duration. Also, although the NHANES is the only large national data set that contains data from actual oral health examinations, it has limited data about many other potentially important experiences of children that might influence their oral health, such as frequency of bedtime feedings, maternal oral health status, family oral hygiene practice, cariogenic microbial flora, or fluoride exposure, each of which is known to be associated with ECC.

CONCLUSIONS

These data provide no evidence that breastfeeding or its duration are independently associated with an increased risk for ECC, S-ECC, or a greater number of decayed or filled tooth surfaces among children ages 2 to 5 years in the United States. In contrast, they corroborate that children living in poverty and Mexican American children are at increased risk for poor oral health in the early years, and they indicate that maternal smoking is another such potential risk factor. Clearly, there is a need for more research to identify specific characteristics of poverty and Mexican American ethnicity that contribute to or cause ECC, and the same applies to children prenatally or postnatally exposed to cigarette smoke. Despite the need for more understanding of how these

factors may be causally related to ECC, the findings reported do not indicate any reason to delay action to improve the oral health of children. Rather, they highlight the need to target children living in poverty, those who are Mexican American, and those whose mothers smoke or smoked during pregnancy for timely caries risk assessment and regular preventive dental visits.

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