Caries Prior to Age 3 and Breastfeeding: A Survey of La Leche League Members

Karin Weber-Gasparoni DDS, MS, PhD *Michael J. Kanellis DDS, MS*
Steven M. Levy, DDS, MPH *Julie Stock, MA*

ABSTRACT

Purpose: The purpose of this study was to conduct a secondary data analysis of results from a 1985 survey of La Leche League International (LLLI) members to further investigate the relationship between breast-feeding and caries prior to age 3 (CPA3).

Methods: Subjects were 576 LLLI mothers who responded to a 23-item questionnaire concerning the following factors for their oldest child: (1) breast-feeding habits; (2) fluoride status; (3) use of antibiotics; (4) carbohydrate ingestion; (5) history of caries; and (6) oral hygiene practices.

Results: CPA3 was reported in 10% of all children breast-fed for more than 3 years. Later weaning was found to be significantly associated with CPA3 (odds ratio [OR]=2.03; *P*=.0001). Late initiation of oral hygiene was marginally associated with CPA3 (OR=0.77; *P*=.08). Among children who developed CPA3, bivariate analyses found a greater frequency of breast-feeding (*P*=.012) and presence of night-time breast-feeding (*P*=.049) to be associated with caries detected at an earlier age. Children with caries on their maxillary incisors were more likely to have been breast-fed at night (*P*=.027) and more frequently during the night (*P*=.032).

Conclusion: This retrospective study, based on a report of La Leche League International members, found later weaning to be significantly associated with an increased likelihood of developing CPA3. (J Dent Child 2007;74:52-62)

KEYWORDS: DENTAL CARIES, BREAST-FEEDING, LA LECHE LEAGUE INTERNATIONAL

A 1994 Centers for Disease Control and Prevention (CDC) conference in Atlanta, Ga., recommended the term "early childhood caries" (ECC) to describe a distinct dental disease that affects the primary dentition at a very young age.[1] According to this definition, ECC is an "infectious disease initially affecting the primary incisors of infants and young children and is associated with inappropriate feeding practices."[1] Historically, other names for this condition have included baby bottle tooth decay (BBTD), nursing caries, nursing bottle syndrome, and rampant caries.[2-10] ECC is currently defined as "the presence of 1 or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth"[11] in children from birth through 71 months of age. In children younger than 3 years old, any sign of smooth-surface caries is indicative of severe ECC.[11-13] Psoter et al[14] proposed and validated a caries pattern of ECC for dental caries in any maxillary incisor surface for children younger than 59 months old.

The etiology of ECC is multifactorial. Early Streptococcus mutans colonization, enamel hypoplasia, poor oral hygiene, and high frequency of sugar consumption are among the many ECC risk factors cited in the scientific literature.[8,15-25] Nocturnal feeding is also described in the literature as playing a major role in caries development, due in part to a reduction of salivary flow during sleeping hours and especially when practiced for prolonged periods of time.[23,26-31]

The prevalence of ECC among disadvantaged groups in the United States can be as high as, or higher than 70%.[32-37]

Dr. Kanellis is assistant dean for Patient Services, College of Dentistry, and professor, and Dr. Weber-Gasparoni is assistant professor, both in the Department of Pediatric Dentistry, and Dr. Levy is professor and Graduate Program Director, Department of Preventive and Community Dentistry, all at The University of Iowa, IA City, Iowa; Ms. Stock is Director of Academic Advising and Assessment, Roosevelt University, Chicago, IL, and is a former medical information liaison, La Leche League International, Schaumburg, IL.
Correspond with Dr. Weber-Gasparoni at karin-weber@uiowa.edu

While there is widespread agreement that sugared beverages contribute to caries development,[38,39] the relative cariogenicity of bovine and human milk is less well understood. The literature suggesting an association between breast-feeding and caries is not conclusive and is based largely on case reports.[40-42] A study conducted by Alaluusua et al[43] concluded that breast-feeding alone does not cause the development of caries or affect levels of Streptococcus mutans in children. A study by Weerheijm et al[44] found that prolonged breast-feeding did not lead to higher caries prevalence. Within-group comparisons, however, suggest that frequent breast-feeding and low exposure to fluoride can be considered factors in caries development.[44] In a study of 36- to 71-month-old low socioeconomic status (SES) Brazilian children, night-time breast-feeding and breast-feeding past 12 months of age were associated with severe ECC.[45] In a systematic review of the literature, Valaitis et al[46] was unable to draw conclusions regarding the relationship between ECC and breast-feeding partly because of inconsistencies in the methodology and differences in definitions of ECC and breast-feeding among reviewed studies.[2,4,8,23,25,28,47-68]

During the 1980s, the predominant feeling among dental professionals was that prolonged, on-demand breast-feeding could lead to dental caries. Women who chose to breast-feed their children on-demand were often counseled by dentists to wean their children by 1 year of age.[69] La Leche League International (LLLI), a Schaumburg, IL-based international organization that promotes the benefits of breast-feeding, however, did not believe at the time that dental caries could be caused by on-demand breast-feeding. Because of the nature of this controversy, in 1985 a medical information liaison with LLLI decided to survey a sample of LLLI mothers to obtain some indication about whether or not these beliefs were based in fact. This liaison devised a dental survey that was approved by 2 dentists, which was subsequently mailed to LLLI members throughout Illinois.[69] The information obtained through this survey, while 2 decades old, has not been reported in the dental literature. A report of the survey findings at this time presents a unique opportunity to revisit the relationship between prolonged on-demand breast-feeding, as reported by members of LLLI.

The purpose of this study was, as reported by La Leche League International-member mothers, to explore the associations between dental caries, breast-feeding, diet, oral hygiene, antibiotics, and fluoride.

METHODS

The relationship between prolonged breast-feeding and the development of caries prior to age 3 (CPA3) was explored by conducting secondary data analysis on results from a 1985 survey of LLLI members. The original survey was designed by a medical information liaison at LLLI whose primary interest was to evaluate the relationship between dental caries and prolonged "on-demand" breast-feeding.[69] The survey was included in a mailing of an Illinois State LLLI newsletter, which was sent to all accredited volunteer LLLI counselors in Illinois. They were encouraged to share the survey with other LLLI members. In addition, while not specifically instructed to do so, some LLLI administrators forwarded the survey to LLLI members throughout the western part of the United States. For this reason, the total number of surveys distributed is unknown.

The survey instrument consisted of 23 questions concerning breast-feeding practices as well as other aspects related to oral health, including:

1. fluoride status;
2. use of antibiotics;
3. carbohydrate ingestion;
4. presence of caries and caries pattern (involving maxillary incisors or not); and
5. oral hygiene practices.

Duration of breast-feeding was assessed by asking "how long" mothers breast-fed their children. Respondents could choose between: (1) under 1 year; (2) 1 to 2 years; (3) 2 to 3 years; or (4) over 3 years. Regarding breast-feeding practices, the questionnaire included questions about: (1) frequency of breast-feeding; (2) age at weaning; and (3) nocturnal breast-feeding habits. Only mothers who reported that their children had caries were asked to respond to questions about frequency of breast-feeding and nocturnal breast-feeding practices. Mothers responded to the survey questions separately for each of their children. For these analyses, only the responses for the first-born child were included.

The primary dependent variable was whether or not the child developed "cavities" prior to age 3, as reported by the LLLI mother. The actual wording of the question in the survey was: "At what age were cavities first detected?" Available responses included: under 1 year; 1 to 2 years; 2 to 3 years; and over 3 years.

Identifying the exact age of children when caries was first detected is not possible, since interpretation of the available age ranges could have varied among respondents. For example, "2 to 3 years" could be interpreted as 24 to 36 months by some and 24 to 47 months by others. For the purposes of these analyses, the corresponding age categories in months (rather than in years) were defined as: 0 to 11 months; 12 to 23 months; 24 to 35 months; and 36 months and older.

With this interpretation, children in the first 3 age groups were classified as "under 3 years of age." Because most of the study sample (66%) was weaned from breast-feeding prior to age 3, the authors were interested in exploring reported caries experience among children under 3 years of age.

Survey responses were entered into a data program (SPSS Statistical Package, version 11.5, SPSS Inc, Chicago, IL) for statistical management. Children who were not breast-fed were excluded from the analyses. Bivariate analyses with the remaining sample were conducted to explore the relationships between the dependent variable, presence of caries prior to age 3 (CPA3), and each independent variable. A second bivariate analysis was done with the subset of children whose mothers reported CPA3 to explore the

association between breast-feeding variables believed to be associated with CPA3 and expressions of caries severity.

The dependent variables for this secondary analysis were measures of caries severity: presence of more than 3 "cavities"; and a caries pattern involving the incisors.[14] Independent variables included: (1) frequency of breast-feeding; (2) occurrence of night-time breast-feeding; and (3) later weaning. Chi-square statistics were used to assess significant bivariate relationships ($P<.05$). Forward stepwise logistic regression analysis was used to simultaneously assess the effects of variables possibly associated with CPA3.

Due to the exploratory nature of the study, the significance level chosen to allow a variable to remain in the model was 0.1. Two-way interactions between significant variables were also tested.

RESULTS

Subjects for this study were 595 mothers belonging to the La Leche League International (LLLI) who responded to a single mailing of a questionnaire concerning their children (Tables 1 and 2). The total number of surveys distributed is not known.

Survey responses from 19 mothers who indicated they did not breast-feed their child (3%) were excluded from further analysis, resulting in a total of 576 surveys for data analysis. The ages of the respondents' first-born children at the time of the survey ranged from 2 to 360 months (30 years), with a median of 95 months (7 years, 11 months) and a mean of 102 months (8 years, 6 months±4 years, 7 months). Demographic information collected for each respondent included: name; address; age; and phone number. Not included in the survey were: mother's race; educational background; and SES levels. Mothers responding to the survey were either LLLI leaders (N=355) or LLLI members (N=221).

The main dependent variable was whether or not the children developed caries prior to age 3 (CPA3), as reported by their mothers. Those children who reportedly developed caries prior to age 3 were included in the "CPA3" group, and those who developed caries at age 3 or later or did not have caries were included in the "No CPA3" group. Using this definition, 58 (10%) of the 576 breast-fed children had CPA3, while 178 (31%) had caries after their third birthday and 338 (59%) did not have caries. Data on the development of caries was missing for 2 out of the 576 participants.

The bivariate analyses between the dependent variable (presence or absence of CPA3) and independent variables found that later weaning was the only significant variable ($P<.001$) (Table 3). Children in the "CPA3" group were breast-fed for a longer period of time (weaned later) compared to children who either did not have caries, or did not have caries before the age of 3. Approximately 64% of children in the "CPA3" group were breast-fed beyond age 3, compared to only 30% of children in the "No CPA3" group. The *P*-value for "initiation of solids" approached significance ($P=.070$; Table 3). This association tends to suggest that age of initiation of solids is inversely correlated

Table 1. Summary of Responses to Survey Questions from all Mothers (N=595)

	Valid %
Breast-fed?	
Yes	97
No	3
If breast-fed, how long (ys)?	
<1	16
1-2	24
2-3	26
>3	34
At what age did this child begin routinely practicing dental hygiene at least once a day (ys)?	
<1	13
1-2	40
2-3	27
>3	20
Was your water source fluoridated during the first 3 years of this child's life?	
Yes	58
No	42
Has the child regularly used fluoridated tooth paste?	
Yes	83
No	17
Did this child receive antibiotics before the age of 1?	
Yes	49
No	51
When were solids started (mos)?	
Before 3	9
3-6	34
After 6	57
Has the child regularly had sweets over 2 x a day (refined sugars, processed foods, cookies, crackers, honey, dried f ruit, and fruit juice)?	
Yes	60
No	40
Did/does this child have cavities?	
Yes	41
No	59

Table 2. Summary of Responses to Selected Survey Questions of Mothers Whose Children Reportedly Developed CPA3 (N=58)

	Valid %
>3 cavities?	
Yes	72
No	28
At what age were cavities first detected (ys)?	
<1	9
1-2	34
2-3	57
Was improvement in dental hygiene effective at arresting the decay?	
Yes	50
No	50
Methods used to manage dental caries:	
Wiping or brushing teeth	
Yes	93
No	7
Dietary changes	
Yes	32
No	68
Repair by dentist	
Yes	91
No	9
Use of topical fluoride	
Yes	55
No	45
Change in nursing habits	
Yes	2
No	98
At the time decay was detected, how often was this child nursing?	
Not nursing when caries detected	19
1-2/day	5
3-5/day	35
≥6/day	41
At the time of the development of decay, did this child nurse at night?	
Yes	80
No	20
If yes, which of the following describes his/her night nursing pattern?	
1-2x/night	38
3-4x/night	51
Child at breast throughout the night	11
What is/was the pattern of decay?	
1-2 random caries	9
Several cavities in front teeth	14
Several cavities in molars	33
Cavities in front and back teeth	44

to development of CPA3. Of children with CPA3, 70% started solids later (after 6 months) compared to 55% of those who did not develop CPA3.

Results from forward stepwise logistic regression analyses (level of significance=0.10) also found later weaning to be significantly associated with the probability of developing CPA3 (OR=2.03; *P*=.0001). Children breast-fed for a longer period of time were at higher risk of developing CPA3 compared to those breast-fed for a shorter period of time. Earlier initiation of daily oral hygiene was significantly associated with lower likelihood of developing CPA3 (OR=0.77; *P*=.08). No other main effects were statistically significant, and the interaction between age of weaning and initiation of oral hygiene was not significant (Table 4).

Among the 58 children reported to have CPA3:

1. 31 (55%) reported exposure to fluoridated water during the first 3 years of life;
2. 48 (83%) reported regular use of fluoridated toothpaste;
3. 27 (47%) indicated the ingestion of antibiotics before the age of 1 year; and
4. 35 (60%) were reported to be exposed to sweets more than twice a day.

No association was found in either bivariate or multivariate analyses between these 4 variables and presence of CPA3.

Forty-two (72%) of the "CPA3" group children reportedly had more than 3 "cavities." In separate bivariate analyses among these 58 children, caries experience of more than 3 "cavities" was not significantly associated with any of the independent variables (later weaning, frequency of breast-feeding, night-time breast-feeding, and night nursing pattern), (Table 5). Also, among these 58, earlier age at which caries was first detected was not significantly associated with night-time nursing pattern or later weaning, but was significantly associated with the presence of night-time breast-feeding (*P*=.049) and a greater frequency of breast-feeding (*P*=.012), (Table 5). Approximately 41% (N=24) of breast-fed children who reportedly developed CPA3 were being breast-fed 6 or more times per day when caries was first detected. Twenty-four percent (N=8) had caries detected between ages 2 and 3 compared to 64% (N=16) that had caries detected before age 2.

This study found that 92% (N=23) of children with CPA3 who reportedly had caries detected before age 2 also presented with a habit of night-time breast-feeding compared to 71% (N=22) for those with caries detected after age 2 (*P*=.049). Overall, results showed that most of the children (80%) with CPA3 were breast-fed during the night when caries was first detected.

Caries pattern (defined as either "incisor pattern" when children were reported to have either several cavities in front teeth or cavities in both front and back teeth or "no incisor pattern" for those reported to have either 1 or 2 random cavities or several cavities in molars) was not significantly associated with later weaning or frequency of breast-feeding, but was significantly associated with night-time breast-feeding (*P*=.027) and night nursing pattern (*P*=.032; Table 5). Almost all children (90%) with a caries pattern involving

the incisors reported a habit of night-time breast-feeding compared to 65% of those who did not have anterior teeth involved. Most of the CPA3 children whose mothers reported a caries pattern involving the incisors (66%) were breast-fed 3 to 4 times during the night, while most of the CPA3 children without anterior caries (56%) were breast-fed 1 or 2 times during the night.

Table 3. Bivariate Analyses Between the Presence of CPA3 and Independent Variables

Independent variables	*P* value
Later weaning*	.001
Initiation of solids	.070
Initiation of oral hygiene	.241
Antibiotics before age 1	.392
Water fluoridation	.403
Regular use of fluoridated toothpaste	.526
Regular sweets	.537
Vitamin C during pregnancy	.545

* Chi-square test statistic; significance=P<.05.

Table 4. Variables Associated With CPA3 in Forward Stepwise Logistic Regression

Variable	Coefficient±SD	*P*-value	Odds ratio	95% confidence interval
Constant	3.72±0.6623	.0001	—	—
Later weaning*	0.71±0.16	.0001	2.03	(1.40, 2.80)

* Significance=P<.10; 2-way interaction was not significant.

DISCUSSION

In the early 1980s, LLLI claimed that the benefits of breast-feeding were well documented in the literature, while a possible link between prolonged breast-feeding and dental caries still remained uncertain.[70] This study reported the results of a unique dental survey designed at that time by a LLLI member who had the desire to better understand the possible link between prolonged "on-demand" breast-feeding and dental caries, with the goal of sharing this information with women who were willing to breast-feed their children unrestrictedly. Both the American Academy of Pediatrics (AAP) and the American Academy of Pediatric Dentistry (AAPD) recognize the importance of promoting breast-feeding, due to the advantages to both mother and child.[71,72] The benefits for the child include:

1. reduced allergic reactions and episodes of otitis media. meningitis, bacteremia, and respiratory and gastrointestinal infections;
2. immunologic protection; and
3. favorable growth and neurodevelopment.[71-73]

Breast-feeding is advantageous for mothers, since it:

a. provides some maternal protection against osteoporosis and breast cancer;
b. allows the uterus to return more quickly to its initial state; and
c. helps with building a strong emotional bond with the child.[73-75]

The AAP's policy[71] on breast-feeding states that "exclusive breast-feeding is ideal nutrition and sufficient to support optimal growth and development for approximately the first 6 months after birth, and it is recommended to continue for at least 12 months, and thereafter for as long as mutually desired." The AAPD's policy, however, recognizes that a potential risk for ECC could exist for breast-fed children who are exposed to unrestricted and repetitive feeding practices with prolonged exposure of teeth to fermentable carbohydrates and inadequate oral hygiene practices. In addition, the AAPD also acknowledges the necessity for further study concerning the relationship between ECC and prolonged on-demand breast-feeding.[72]

The terminology "caries prior to age 3" (CPA3) was chosen as the definition for the study's reported caries data for specific reasons:

1. Because this study conducted secondary analysis of results from a survey of LLLI members, the authors believed it wouldn't be appropriate to define the reported caries data as the current AAPD definition of ECC[12] since caries data were based solely on maternal report.

2. CPA3 seemed a more appropriate definition because most children of the study sample were weaned from breast-feeding before age 3 and the main focus of this study was to explore caries experience among breast-fed children under 3 years of age.

Based on the maternal report, this research study found that the majority of breast-fed children (90%) did not develop CPA3. Of the 10% of breast-fed children who reportedly developed CPA3, later weaning was found to be significantly associated with the development of caries in both bivariate and multivariable analyses. An association between duration of breast-feeding (later weaning) and development of dental caries was previously reported by Tsubouchi et al.[8] The authors concluded that children exposed to a greater duration of breast-feeding were more likely to develop dental caries. They acknowledged other significant contributing factors for the caries development among these children, however, including inappropriate dietary habits, and oral hygiene habits. Eronat and Eden[24] also found duration of breast-feeding to be associated with dental caries. In their study, most of the children with caries were also reported to have an unbalanced diet rich in sugars and a practice of on-demand breast-feeding. *Azevedo et al* found night-time breast-feeding and breast-feeding in children older than 12 months of age to be correlated with

Table 5. Associations Between Presence of More Than 3 "Cavities," Age Caries Was First Detected, Caries Pattern, and Independent Variables*

Independent variables	Presence of >3 "cavities"				Total		Chi-square *P*-value	Age (ys) caries was first detected				Total		Chi-square *P*-value	Caries pattern				Total		Chi-square *P*-value
	Yes	%	No.	%	No.	%		0-2	%	2-3	%	No.	%		Incisor	%	No incisor patter	%	No	%	
Later weaning (age of weaning; ys)																					
<1	4	10	0	0	4	7		1	4	3	9	4	7		1	3	3	13	4	7	
1-2	4	10	2	12	**6**	**10**	Chi-square =2.05	3	12	3	9	**6**	**10**	Chi-square =0.67	4	12	2	9	**6**	**11**	Chi-square =0.67
2-3	7	16	4	25	**11**	**19**	*P*=561	5	20	6	18	**11**	**19**	*P*=.874	5	16	5	22	**10**	**18**	*P*=.461
>3	27	64	10	63	**37**	**64**		16	64	21	64	**37**	**64**		22	69	13	56	**35**	**64**	
Total	**42**	**100**	**16**	**100**	**58**	**100**		**25**	**100**	**33**	**100**	**58**	**100**		**32**	**100**	**23**	**100**	**55**	**100**	
Frequency of breast-feeding																					
Not nursing	8	19	3	19	**11**	**19**		2	8	9	27	**11**	**19**		4	13	7	30	**11**	**20**	
1-2x/day	2	5	1	6	**3**	**5**	Chi-square =5.82	–	0	3	9	**3**	**5**	Chi-square =11.02	1	3	2	9	**3**	**5**	Chi-square =5.30
3-5x/day	11	26	9	56	**20**	**35**	*P*=.121	7	28	13	40	**20**	**35**	*P*=.012†	10	31	8	35	**18**	**33**	*P*=.151
≥6x/day	21	50	3	19	**24**	**41**		16	64	8	24	**24**	**41**		17	53	6	26	**23**	**42**	
Total	**42**	**100**	**16**	**100**	**58**	**100**		**25**	**100**	**33**	**100**	**58**	**100**		**32**	**100**	**23**	**100**	**55**	**100**	
Night-time breast-feeding																					
Yes	33	80	12	80	**45**	**80**	Chi-square =0.02	23	92	22	71	**45**	**80**	Chi-square =3.87	28	90	15	65	**43**	**80**	Chi-square 5.13
No	8	20	3	20	**11**	**20**	*P*=.619	2	8	9	29	**11**	**20**	*P*=.049†	3	10	8	35	**11**	**20**	*P*=.027†
Total	**41**	**100**	**15**	**100**	**41**	**100**		**25**	**100**	**31**	**100**	**56**	**100**		**31**	**100**	**23**	**100**	**54**	**100**	
Night nursing pattern																					
1-2x/night	12	35	6	46	**18**	**38**		6	26	12	50	**18**	**38**		8	27	9	56	**17**	**38**	
3-4x/night	18	53	6	46	**24**	**51**	Chi-square =0.52	13	57	11	46	**24**	**51**	Chi-square =3.94	19	66	4	25	**23**	**51**	**Chi-square =6.85**
Child on breast throughout night	4	12	1	8	**5**	**11**	*P*=.771	4	17	1	4	**5**	**11**	*P*=.139	2	7	3	19	**5**	**11**	*P*=.032†
Total	**34**	**100**	**13**	**100**	**47**	**100**		**23**	**100**	**24**	**100**	**47**	**100**		**29**	**100**	**16**	**100**	**45**	**100**	

* *Bivariate analyses among the 58 children who reportedly developed CPA 3*

† *Significance=P<.05.*

severe ECC.[45] The study sample comprised of underserved low-income Brazilian children of parents with a low educational level, which itself is by nature already a high-risk population for ECC. This cross-sectional study investigated the association between severe ECC and feeding practices only in children receiving dental treatment in a public health center. Important variables associated with ECC, such as home oral hygiene practices and clinical plaque scores, were not included in the study's analyses.[45]

Not all studies, however, have reported an association between duration of breast-feeding and the development of dental caries. Tank and Storvick[76] concluded that breast-feeding practiced longer than 3 months was associated with a decreased occurrence of caries among the children studied. Weerheijm et al[44] found that prolonged breast-feeding did not lead to higher caries prevalence. Both greater night and

day frequency of breast-feeding and low fluoride exposure, however, were important factors in the development of caries. Duration of breast-feeding also had no association with dental caries in a study conducted by Matee et al.[23] A strong association was found, however, between caries development and the habit of allowing children to sleep with the breast nipple in their mouths.

The association between later initiation of solids and the development of CPA3 in this study approached significance in the bivariate analysis, suggesting that early introduction of solids could be protective of dental caries. This trend is not supported by the literature. It is suggested that the earlier a child starts eating solids, the earlier he/she could be exposed to inappropriate feeding practices, which could increase caries prevalence.[47] Al-Dashti et al[47] showed that breast-feeding practices were associated with a delay in introducing sugar to the diet, which offered a further indirect advantage. Earlier weaning from the breast could also increase the likelihood of bottle feeding, which, in turn, is associated with caries prevalence in preschool children.[77] In this study, later weaning was not controlled for in the analysis and logistic regression analysis also showed no significant association between CPA3 and initiation of solids.

Some studies have shown a significant relationship between oral hygiene status and the incidence of dental caries[10,78,79] while others have not.[55,80,81] Professional consensus suggests that oral hygiene should begin with the eruption of the first tooth, since formation of dental plaque on the dental surfaces is considered a risk factor for dental decay.[82] Alaluusua and Malmivirta[19] reported visible plaque to be the best predictor of future caries risk in 92 19-month-old children who were followed for 1½ years. Fraiz and Walter[22] investigated the factors associated with the development of dental caries in preschool children receiving routine dental care and found the presence of visible plaque on the maxillary incisors to be strongly associated with the development of dental caries. In the study, multivariable analysis found later initiation of daily oral hygiene to be marginally associated with the development of CPA3 (P=.08; OR=0.76). Late initiation of daily oral hygiene (after age 3) was seen in only 10% of the breast-fed children who developed CPA3. The survey instrument, however, did not assess how effective the oral hygiene was, the periods during the day when it was accomplished, or whether or not tooth-brushing was accomplished by the parents or by the children.

Results from the bivariate analyses conducted in the secondary analyses for children who developed CPA3 suggest that the presence of night-time breast-feeding habit and both greater night and day nursing frequency could be important factors associated with CPA3. Caution is necessary in interpretation, however, since no further multivariable analyses were conducted due to the small number of subjects (N=58).

The literature on night-time breast-feeding is not as extensive as for bottle-feeding. Nocturnal feeding, however, has been extensively implicated in the literature as a predisposing factor in caries development. Many authors have reported their concern for allowing children to be either bottle- or breast-fed "on-demand" during the night.[23,28-30,83] One reason for their concern is that saliva flow decreases markedly during the sleeping hours, which is thought to affect mechanical self-cleansing and buffering capacity following fermentation of cariogenic substrate.[10,29-31] The frequency of breast-feeding during night sleeping hours has been reported in the literature to be more harmful to a child's dental health than the frequency of breast-feeding during the day. Derkson and Ponti[7] found frequency of nocturnal breast-feeding to be a factor related to caries development. On the other hand, frequency of breast-feeding during the day has been reported to have no association with dental caries.[23] It is possible that the night-time breast-feeding practices as well as high frequency of breast-feeding of children in the current study with CPA3 placed them at higher risk for dental caries. It would be inappropriate, however, to consider the breast-feeding practices of these children as the only causative factors in the development of this dental disease based solely on the information collected in this LLLI survey.

Although human milk has been reported to be more cariogenic than bovine milk, no study has shown human milk alone to be a sufficient predisposing factor in caries development. Erickson et al,[84] after a series of studies on human breast milk, concluded that human breast milk alone in an *in vitro* model is not cariogenic. However, if another carbohydrate source is available for bacterial fermentation and the child is exposed to unlimited breast-feeding, human milk can be highly cariogenic.[84]

In the current study, when mothers of children with CPA3 were asked about the methods they used to manage the carious process in their child, 98% of them reported no changes in their nursing practices. This was not surprising, since LLLI mothers are known to be devoted to their beliefs about the benefits of breast-feeding. In a 1996 statement regarding breast-feeding and dental caries,[70] LLLI officially stated that all the benefits from breast-feeding should be taken into consideration against "any self-limiting risk of dental caries in the primary teeth in early childhood." A more recent LLLI publication has cited that "…weaning is not required to prevent and treat early childhood caries."[85] The present study's design did not assess whether the children who developed caries were still nursing at the time caries was detected. It is possible that breast-feeding could have already ceased when caries was detected, so no changes in nursing practices could actually have been made by the mother.

This research study was subject to the limitations of the retrospective studies based on maternal recall, survey instrument, study sample, and that caries data were self-reported.

The survey instrument used by LLLI had several deficiencies, partially related to wording of the questions and failure to gather information on all items from all the respondent mothers. Although no actual skip pattern was built into the survey, 12 of the 23 questions were written in such a way that only mothers whose children had caries were supposed to answer them. Thus, there was substantial missing data

and loss of important information about those children who were breast-fed and did not develop dental caries.

It is also important to acknowledge that very little is known about the respondents, since it was not possible to determine the number of questionnaires sent or the response rate for the survey. Important confounding variables, such as SES and educational levels of the responding mothers, were not controlled for in this study. Some of these mothers' responses could have been subject to bias due to their beliefs about the benefits of breast-feeding, especially in those questions assessing frequency of breast-feeding, presence of night-time breast-feeding, and night-time nursing pattern at the time of caries development or detection.

Although this survey was conducted approximately 21 years ago, the feeding practices among LLLI mothers today, as well as the LLLI position regarding breast-feeding and dental caries, remain the same.[83] La Leche League continues to encourage mothers to respond to their babies' desire to nurse on demand and throughout the night. Concerns about and prevention of dental caries are addressed in articles published by the organization and at local and national conferences. LLLI encourages parents to foster good dental health during the time breast-feeding continues.[85-87]

Health professionals should recognize the benefits of breast-feeding and educate mothers who choose to breast-feed their child "on-demand" about the remaining uncertainties concerning prolonged unrestricted breast-feeding, and the importance of implementing beneficial dental habits to assure a child will reach a healthy dental balance.

Specific recommendations should include:

1. a consistent daily oral hygiene regimen as early as possible, conducted by an adult;
2. a healthy diet, low in carbohydrates;
3. exposure to optimal fluoride levels and daily use of fluoridated toothpaste; and
4. routine early professional dental care.

CONCLUSIONS

Based on a maternal report of La Leche League International-member mothers, this study found that of the breast-fed children in this study, 10% reportedly developed caries prior to age 3. Later weaning was the only variable significantly associated with an increased likelihood of reportedly developing caries prior to age 3.

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