

Feeding habits as determinants of early childhood caries in a population where prolonged breastfeeding is the norm

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Abstract - Objectives: To investigate the impact of feeding habits and daytime sugar intake on the prevalence of early childhood caries in a population where prolonged breastfeeding is a norm. Methods: A cross-sectional study was carried out at 18 of 102 public health centers in Tehran. During a 4-day period at each center, between 20 and 35 children aged 1-3 years were enrolled, resulting in a sample of 504 children. In structured interviews, mothers were asked to give information about their child's feeding habits, daytime sugar intake, and their family's background. Sugar intake during the night was operationalized as separately calculated burdens of nighttime breastfeeding and bottle-feeding. Clinical dental examinations followed the World Health Organization criteria. Data analysis included chi-square test, t-test, ANOVA, and logistic regression modeling. Results: Of the children, 56% were solely breastfed (mean duration 16.6 months; 95% CI 16.0-17.2), 42% were both breastfed and bottlefed, and 2% were solely bottle-fed. Mean duration of breastfeeding for the solely breastfed 24- to 36-month olds was 22.8 months (95% CI 21.8-23.9). At bedtime, 69% were breastfed, 11% bottle-fed, and 20% were not fed at all. With respect to feeding during the night, 72% of children were breastfed, 12% were bottle-fed with milk, 1% received a bottle with water, while 15% were not fed. Early childhood caries (ECC) occurred in 3-26% of the children, depending on age group (P < 0.001). The burden of milk-bottle feeding at night was a clear determinant for ECC (OR = 5.5) whereas breastfeeding per se, its duration, the burden of breastfeeding at night, and daytime sugar intake were not. Conclusion: On account of its association with ECC, milk-bottle feeding at night should be limited, whereas prolonged breastfeeding appears to have no such negative dental consequences.

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The World Health Organization (WHO) has recommended that children be breastfed until age 24 months (1). On the other hand, prolonged exposure of teeth to breastfeeding (2–5), bottlefeeding (2, 6, 7), and feeding at night (2, 4, 5, 8) have been identified as risk factors of early childhood caries (ECC). Consequently, weaning from breast and/or bottle is recommended by dental professionals soon after the child's first birthday (4, 9). A wider spectrum of information about feeding habits and sugar intake would probably elucidate the factors promoting ECC. So far, however, reports on the interplay of these factors and their impact on ECC remain controversial (10, 11).

Patterns of sugar consumption are established early in life, and sugar consumption increases during the first 2 years (12). Sugar consumption is higher in the Middle-Eastern countries than in other developing countries (3), and failure to implement proper oral health programs may well lead to higher rates of dental caries than elsewhere (13). Although frequent consumption of sugary snacks has been associated with ECC (11, 14, 15), other reports dispute the existence of such a relationship (16–18). A similar discrepancy exists regarding a relationship between parents' socioeconomic status (SES) and childhood caries rates (3, 19, 20). The possible influence of SES on dental health may be a consequence of differences in dietary habits and the role of sugar in the diet (13). This study investigated the impact of feeding habits and daytime sugar intake on ECC in a population where prolonged breastfeeding is the norm.

Methods

Subjects

The data for this study were collected in Iran, where prolonged breastfeeding is commonly recommended and practiced. The target population, 1- to 3-year olds, was reached at public health centers, where the children of most families, regardless of the socioeconomic level, are vaccinated. Using a list provided by the Ministry of Health and Medical Education, 18 of 102 public health centers were randomly selected, representing all districts in Tehran. The number of selected centers was proportional to the total number of centers in that region. The sample included children from 1 to 3 years of age who visited the vaccination and development assessment offices of the public health centers from January to March 2005. During a period of four working days at each health center, between 20 and 35 children were enrolled per center, producing a total sample of 504 children consisting of 254 boys and 250 girls (21). Prior to the child's clinical dental examination, the mothers were interviewed based on a pre-tested, structured questionnaire in order to obtain information about the child's feeding habits, daytime sugar intake, and the family's background.

Feeding habits

Feeding habits covered feeding method, total duration of prior breastfeeding, total duration of prior bottle-feeding, and nighttime feeding practices. The question about the feeding method had three response alternatives: breastfeeding only, bottle-feeding only, or both. The responses to this question were later dichotomized as solely breastfed or not. The total duration of breastfeeding and/or bottle-feeding was recorded in months.

Mothers were asked to answer one question about feeding at bedtime for the purpose of helping the child fall asleep. The mothers were asked to respond by selecting one of four alternatives: breast, bottle containing liquids other than water, both breast and bottle, and neither breast nor bottle given at bedtime. Those who, at bedtime, were both breastfed and bottle-fed (n = 13) were excluded from further analysis.

Information about feeding during the night was elicited in two questions: (i) What is done in case the child wakes up during the night? and (ii) How many times do you usually feed your child during the night? The responses to the first question were categorized (the related scores given in parentheses) as (a) comforting the child or giving him/her a pacifier or a bottle containing water (0), and (b) either breastfeeding or giving a bottle containing a liquid other than water (1). Preliminary analysis showed that with three exceptions, the bottle contained milk. These three outliers were also excluded from further analysis. The frequency of feedings (other than water) during the night was categorized as none (0), one to two times per night (1), three to seven times per night (2), and whole night (3). Sugar intake during the night was then operationalized as separately calculated burdens of nighttime breastfeeding and bottle-feeding. The higher scores indicated a higher burden of nightfeeding in terms of sugar intake. The burden of nighttime breastfeeding, ranging from 0 to 3, was categorized as none (0), low (1), and high (2-3). Burden of milk-bottle feeding during the night was dichotomized into non-existent (0), and existent (1-2).

Daytime sugar intake

The indicator of child's daytime sugar intake combined the following four aspects. The responses and the related scores (in parentheses) were categorized as follows:

(i) Two most common contents of daytime bottle, subsequently categorized as neither content being sweet (0), one being sweet (1), and both being sweet (2).

(ii) Frequency of giving sugary snacks: seldom or never (0), once a day (1), twice a day (2), three times a day (3), four times a day (4), and five times a day or more (5).

(iii) Frequency of antibiotic administration defined as the number of courses administered

during the previous 12 months, categorized as: no usage (0), 1 to 2 courses (1), 3 to 5 courses (2), and more than 5 courses (3).

(iv) Iron drop usage, categorized as: no usage (0), usage followed immediately by water (1), and usage without any water (2).

The higher scores indicated a higher sugar intake. The sum of these scores, ranging from 0 to 12, described daytime sugar intake as low (0-5), moderate (6), and high (7-12).

Clinical examination

Prior to the clinical dental examinations, one of the authors (SZM), with 5 years of experience as a practicing dentist, was further trained by an experienced pediatric dentist who was the head of a university department of pediatrics. The training included a double examination of 10 children that showed complete intra-examiner reliability of the diagnoses regarding the presence of decayed teeth (dt). Dental examinations were carried out with the help of a headlamp and a plane dental mirror, with the mother and examiner sitting in a knee-to-knee position, the child on their laps and the mother controlling the child's feet and hands. The criteria for caries diagnoses conformed to WHO recommendations (22). ECC was defined as the presence of any dmf teeth (14).

Background information

Child's age, gender, and SES as described by parents' level of education and family income served as background information. The child's age was recorded with an accuracy of 1 day. In order to insure greater homogeneity with regard to the extent of primary dentition, three age groups were formed: 12-15 months, 16-23 months, and 24-36 months of age. The two youngest groups were somewhat overrepresented because of the recommendation that vaccination take place at 12 and 18 months of age. Information regarding level of education was requested separately for the father and mother using a seven-point scale ranging from illiterate to doctoral degree. The educational level of the parents was defined as the highest level of either parent's education and then categorized into low (primary school or illiterate), moderate (diploma or high school education), and high (university education). The response to an open-ended question about the family income per month was to be given in Rials (9100 Rials = 1 USD). The reported income was then standardized for a family of four and corrected for non-tenant families by adding a fixed amount (110 USD) in order to approximate net family income. The indicator of family income was later categorized as low (less than 200 USD), moderate (200–399 USD), and high (at least 400 USD). For 19% of the enrolled children, parents' level of education was low, for 47% moderate and for 34% high. The corresponding figures for family income were 12%, 47%, and 41%. Distributions of the children by parents' level of education and family income showed no differences between the age groups or genders.

Statistical analysis

Evaluation of the statistical significance of the differences between the subgroups included the *t*-test and ANOVA for comparison of mean values and the chi-square test for frequencies. A logistic regression model served for the multivariable assessment of factors related to the ECC. The corresponding odds ratios (OR) and their 95% confidence intervals (95% CI) were determined. Goodness of fit was assessed by means of the Hosmer and Lemeshow test.

Ethical consideration

The study was approved by Ethics Committee of the School of Dentistry, Shaheed Beheshti Medical University. The mothers were asked to give informed consent to participate in the study, only two refused (21). The data pertaining to the subjects were entered into the database with a numerical code only.

Results

Breastfeeding was the norm: of the children (n = 488 after exclusion of 16 children), 56% weresolely breastfed, 42% were both breastfed and bottle-fed, and 2% were solely bottle-fed. Fortynine percent of the children were solely breastfed in the high-income families, compared with 62% and 59% for the moderate- and low-income families, respectively (P = 0.04). For the solely breastfed children, the duration of breastfeeding was 16.6 months (95% CI 16.0-17.2) and for those who were both breast- and bottle-fed, 11.4 months (95% CI 10.5-12.3). For 24- to 36-month olds these figures were 22.8 (95% CI 21.8-23.9) and 15.4 (95% CI 12.5-18.3), respectively. Figure 1 shows distributions of the children according to the duration of breastfeeding separately for the three age



Boxes and whiskers = Quartiles, Bold line = Median, X = Mean, Circle = Outlier

Fig. 1. Distribution of 1- to 3-year olds (n = 488) in Tehran, Iran, by duration of breastfeeding according to age group.

groups. No differences in these figures between boys and girls were observed. For the 24- to 36month olds, median duration of breastfeeding was 24 months.

At bed-time, 69% were breastfed, 11% bottlefed, and 20% were not fed at all. During the night 72% of the children were breastfed, 12% were bottle-fed with milk, and 1% were bottle-fed with water, while 15% were not fed at all. Burden of nighttime breastfeeding was high for 32% of the

children, low for 26% and nil for 42%. The older age group (24-36 months) and children from families with a higher income had the lowest scores (P < 0.05). The burden of milk-bottle feeding during the night was existent for 11% of the children and non-existent for 89%. The older age groups received the lowest scores (P < 0.05). No gender-based differences appeared in these figures. Daytime sugar intake differed by age: in the youngest age group it was low for 56% and high for 28% of the children, while for the oldest age group the corresponding figures were 31% and 43% (*P* = 0.001). Daytime sugar intake was lower for the children of highly educated parents (P = 0.006) and did not vary according to the family income.

Early childhood caries (ECC) occurred in 3–26% of the children, depending on age group (P < 0.001). As shown in Table 1, ECC were more likely to occur in the solely breastfed children (OR = 2.1). ECC showed no relationship (P > 0.05) with daytime sugar intake, burden of nighttime feeding or SES.

Mean numbers of dmf teeth differed by age group (P < 0.001), but no gender differences were observed within the age groups. With one exception, all dmf teeth were untreated caries (dt). Table 2 shows mean numbers of dt for the three

Table 1. Percentages of 1- to 3-year olds (n = 488) having ECC according to feeding habits and daytime sugar intake, in three age groups, in Tehran, Iran

	Age groups (n				
Factors	12-15 (<i>n</i> = 236)	16-23 (<i>n</i> = 153)	24–36 (<i>n</i> = 99)	Odds ratio	95% CI
Feeding method					
Breast- and bottle-fed	2	8	17	1.0	
Solely breastfed	3	14	32	2.1	1.0-4.2
Duration of breastfeeding					
0–6 months	0	13	14	1.0	
>6 months	3	11	27	1.7	0.5-6.0
Burden of the nighttime brea	stfeeding				
None	2	11	26	1.0	
Low	3	6	0	0.6	0.2 - 1.7
High	3	7	40	1.7	0.7–3.7
Burden of the nighttime milk	k-bottle feeding				
Non-existent	2	11	25	1.0	
Existent	4	10	67	1.5	0.5-4.3
Feeding at bed-time					
No breast or bottle	2	8	15	1.0	
Bottle-feeding	4	6	17	1.1	0.3-4.6
Breastfeeding	3	13	30	1.9	0.7-5.2
Daytime sugar intake					
Low	2	9	23	1.0	
Moderate	0	14	32	1.4	0.6-3.3
High	4	12	26	1.3	0.6–2.7

Statistical evaluation by logistic regressions separately for each variable, controlling for age.

age groups according to feeding habits and daytime sugar intake. Those children who were both breastfed and bottle-fed or who had a low burden of nighttime breastfeeding exhibited lower dt (P < 0.01).

A logistic regression analysis showed that ECC were more likely to occur among the older children (OR = 1.2; P < 0.001) and among those for whom the burden of milk-bottle feeding at night existed

(OR = 5.5, P < 0.05; Table 3). Breastfeeding *per se*, its duration, its nighttime burden, and daytime sugar intake were not related to ECC. The model fitted well (Hosmer and Lemeshow, P = 0.5). A separate logistic regression model for those children who were solely breastfed during the night showed that age was the only factor having an impact on ECC. Another logistic regression model for those children who were solely bottle-fed during the night

Table 2. Mean dt among 1- to 3-year olds (n = 488) in Tehran, Iran, by feeding habits and daytime sugar intake, in three age groups

	Age gro	Age groups (months)					
Factor	12–15	12–15		16–23		24–36	
	n	dt	n	dt	n	dt	P-value
Feeding method							
Breast- and bottle-fed	112	0.0	65	0.2	36	0.4	0.00
Solely breastfed	124	0.1	88	0.3	63	1.1	
Duration of breastfeeding							
0–6 months	38	0.0	16	0.3	7	0.3	0.25
>6 months	198	< 0.1	137	0.3	92	0.9	
Burden of the nighttime bre	astfeeding						
None	68	0.0	55	0.2	83	0.7	0.00
Low	72	0.0	50	0.1	6	0.0	
High	96	< 0.1	48	0.5	10	2.5	
Burden of the nighttime mil	k-bottle feeding	ng					
Non-existent	208	0.0	133	0.3	96	0.9	0.9
Existent	28	0.0	20	0.3	3	1.0	
Feeding at bed-time							
No breast or bottle	58	0.0	26	0.2	13	0.4	0.1
Bottle-feeding	25	0.0	16	0.3	12	0.4	
Breastfeeding	153	0.0	133	0.3	74	1.0	
Daytime sugar intake							
Ĺow	132	< 0.1	65	0.2	31	0.7	0.3
Moderate	37	0.0	28	0.2	25	1.3	
High	67	< 0.1	60	0.4	43	0.7	

Statistical evaluation by ANOVA for each variable controlling for age.

Table 3. Factors related to presence of ECC among 1- to 3-year olds (n = 488) in Tehran, Iran, as explained by a logistic regression model

	Estimate of		Odds ratio		
Parameters in the model	strength	Standard error	OR	95% CI	P-value
Feeding method: 1 = breast and bottle, 2 = breast only	1.018	0.758	2.7	0.6–12.2	0.179
Duration of breastfeeding	-0.043	0.044	1.0	0.9-1.0	0.331
Duration of bottle-feeding	-0.013	0.045	1.0	0.9–1.1	0.764
Burden of the nighttime breastfeeding	0.330	0.206	1.4	0.9-2.1	0.110
Burden of the nighttime milk-bottle feeding	1.704	0.482	5.5	2.1 - 14.1	0.000
Feeding at bed-time					
1 = No breast or bottle			1.0		
2 = Bottle	-0.547	0.879	0.6	0.1–3.2	0.534
3 = Breast	0.595	0.607	1.8	0.6-6.0	0.327
Daytime sugar intake	0.116	0.095	1.1	0.9 - 1.4	0.222
Age in months	0.191	0.035	1.2	1.1–1.3	0.000
Gender: $1 = girls$, $2 = boys$	0.450	0.361	1.6	0.8-3.2	0.212
Parents level of education	-0.303	0.174	0.7	0.5 - 1.0	0.081
Family income	0.001	0.001	1.0	1.0 - 1.0	0.044

Goodness of fit with Hosmer and Lemeshow test (P = 0.5).

showed that age and milk-bottle feeding at night showed the strongest impact on ECC.

Discussion

This study offered a good opportunity to consider the multifactorial nature of ECC in a population where prolonged breastfeeding is the norm by taking feeding habits, daytime sugar intake, and family SES into account. The existence of the burden of nighttime milk-bottle feeding showed a prominent impact on ECC in our sample, whereas breastfeeding, its duration, the burden of breastfeeding at night, and daytime sugar intake were not related to ECC.

This study showed that 98% of the children had been solely or partly breastfed. This figure is similar to corresponding figures reported for Jordan and India (3, 23), but somewhat higher than those reported for the Far East, where ECC prevalence is also higher than that in the Middle East (14). Reports suggesting that breastfeeding per se is a risk factor for ECC are based on the fact that breast milk, compared with cow's milk, has lower mineral and protein contents and a higher concentration of lactose (24). However, a recent systematic review suggests that no scientific evidence has been presented in support of the cariogenicity of human milk (1). An initial analysis of our data indicated that ECC were more likely to occur in children who were solely breastfed than in other children. However, multivariable analysis indicated that the role of feeding method diminished and, in line with two recent papers (10, 25), neither breastfeeding per se nor its duration was related to ECC.

In this study a comprehensive assessment of the possible implications of nighttime feeding for development of ECC was carried out by including several nighttime feeding habits in the structured interviews and by conducting frequency analyses. This approach offers advantages that are lacking in studies in which simply the presence or absence of nighttime feeding is recorded or in which various aspects of nighttime feeding are not taken into account. Although the use of a wide variety of methodologies makes cross-study comparisons difficult, it seems that nighttime feeding among our 1- to 3-year olds was more common than that reported for corresponding age-groups elsewhere (6, 8, 26, 27). The alarming finding concerning the existence of the burden of milk-bottle feeding at night in these children points to the need to provide mothers with instructions and guidance in these feeding practices.

Feeding during the night may lead to prolonged exposure to fermentable carbohydrates and create dentally harmful environments in the oral cavity (6, 8, 10, 28-32). In the current study, after controlling for all other variables the burden imposed by milk-bottle feeding at night appears to constitute a strong risk factor for the development of ECC. This finding indicates that more emphasis should be placed on avoiding milkbottle feeding at night, even if the milk is not sweetened. Especially interesting in this context is the almost unanimous preference for milk in nighttime bottle-feeding. In Iran, this milk usually includes formulas for the younger children and cow's milk for the older ones. One limitation of this study was the lack of detailed information about the various brands of formulas that were used to feed the children.

A diet rich in non-milk extrinsic sugars has been considered to be cariogenic for infants' and toddlers' teeth (23, 33), although reservations have also been reported (16-18). In addition, the introduction of sugary foods and drinks at an early age is known to lead to the establishment of a habit that persists into maturity (15). In this study, the multivariable analysis was unable to establish any relationship between child's daytime sugar intake and ECC. Our measurement of daytime sugar intake covered a broad range of sugar-containing substances consumed by children, including antibiotics and iron drops, both of which commonly contain sugar in Iran and therefore may be cariogenic. Because 100% juice has been reported to be non-cariogenic (11, 32, 34), it was not included in our indicator of daytime sugar intake. A recent systematic review has shown that children of parents with low education have higher sugar intake, leading to higher caries figures (1). Here, however, the relationships between SES indicators and ECC remained minor.

In conclusion, as ECC was associated with milkbottle feeding at night, this practice should be curtailed for children, whereas prolonged breastfeeding appears to have no such negative dental consequences.

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