The Role of Feeding Practices as a Determinant of the pufa Index in Children with Early Childhood Caries

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Objective: *To evaluate the prevalence and severity of untreated dental caries among young children (aged <6 years) with early childhood caries (ECC) using the pufa index and to examine the relationship between caries and feeding practices.* ***Study Design:*** *A cross-sectional study of children with ECC was undertaken in two stages: a questionnaire survey based on interviews and an intraoral examination using the defs and pufa indices.* ***Results:*** *The overall prevalence of untreated dental caries in our sample of 238 ECC-affected children was 72.3%. The abscess component (code a) was the most common condition. There was an increase in the ECC patterns and the severity of untreated dental caries with increasing age for all teeth groups. ECC and untreated caries lesions for the various teeth groups and study sites varied inversely with current feeding status. The majority of the children had posterior ECC, and the fewest were affected by ulceration (code u) as a consequence of untreated dental caries. Except for the posterior caries pattern, all other caries patterns and pufa components (code u alone, p<0.05) had a significantly higher prevalence among children with nocturnal feeding practices (p<0.001). Binary logistic regression analyses revealed that older age (p<0.05) and nocturnal feeding practices (p<0.001) were significantly associated with pufa scores>0.* ***Conclusion:*** *These data provide valuable evidence of the effect of nocturnal feeding as an important determinant of the increased prevalence of untreated caries lesions among children with ECC.*

Key words: *untreated dental caries, feeding habits, index, children, primary dentition*

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INTRODUCTION

Early childhood caries (ECC) is a serious global oral health problem in both developing and industrialized countries.[1] It has been described as the most common chronic disease affecting young children up to the age of 6 years.[2] However, children's ill-health episodes, environmental factors or individual behaviors may increase the risk of this chronic disease and other adverse outcomes throughout life.[3] This is particularly true in the case when ECC is left untreated; it impacts quality of life to an extent similar to that of other systemic diseases and can lead to dental pain that adversely affects an individual's anthropometric and nutritional status, socialization, self-esteem and learning abilities.[4] Although ECC is largely preventable, its prevalence rate varies significantly, from 19.9 to 27.9% in high-income countries to up to 85% in developing countries.[5]

In the dental literature, various terminologies have been used for ECC, such as nursing caries, nursing bottle syndrome, baby-bottle tooth decay and night bottle mouth, signifying that feeding habits are a significant risk indicator for the development of carious lesions. To capture the multifactorial characteristics of such rapidly progressing caries in young infants and preschool children without merely focusing on language pertaining to cause and effect, the term 'early childhood caries' has been recommended.[6] Evidence suggests that teeth are prone to ECC shortly after eruption and prior to final maturation; within that window, ECC progresses rapidly,

with detrimental effects on dentition.[7] Moreover, in addition to the presence of visible plaque and developmental enamel defects, high-frequency intake of sugary snacks and/or drinks, particularly bottle feeding during the night, increases the risk of ECC's initiation and progression.[8]

Over the years, researchers have used the universally accepted DMFT/deft index for data on caries prevalence. Although this index provides information about caries and related restorations and extractions, it fails to provide information about the more serious clinical consequences of untreated dental caries, such as pulpal involvement and abscess.[9] There is a global epidemic of untreated caries in children, and its burden on quality of life has been documented in several studies.[4, 10]

To assess the presence and severity of oral conditions resulting from untreated caries, the PUFA/pufa index was developed and validated in a national oral health survey in the Philippines. This index introduced by Monse *et al* [9] to compliment the commonly used caries indices that have been proven relevant for epidemiological surveys. Since the index was introduced, a limited number of studies have recorded data on the prevalence of untreated dental caries. However, no attempt has been made to assess the severity and prevalence of untreated dental caries among young preschool children with ECC and the association between ECC and feeding practices.

The purpose of this study was to evaluate the prevalence and severity of untreated dental caries among children with ECC using the pufa index and to determine the role of past and current feeding practices that may have influenced the pattern and severity of current ECC.

MATERIALS AND METHOD

This cross-sectional study was conducted among children who attended the Outpatient Department of Pedodontics and Preventive Dentistry, Saveetha Dental College and Hospital, Chennai, India, for ECC treatment between March 2012 and January 2013. Ethical clearance was obtained from the Institutional Human Ethics Committee following approval from the Scientific Review Board, Saveetha University, Chennai, India (SRB Ref. No. 039). For the oral examinations, prior written informed consent was obtained from the accompanying parent or guardian before the study began.

The reference population included 238 children of both genders. Convenience sampling was used for sample selection. The sample size was calculated for a power of 90% based on a previous report on the prevalence of ECC in preschool children in Davangere and its relationship with feeding practices and family socioeconomic status.[11]

Pilot study and examiner calibration

Training and calibration exercises were conducted prior to the main study. The trained dentists underwent caries diagnostic standardization with a pilot study in which 20 children were successively examined. These 20 children were not included in the final survey. Intraexaminer variability was calculated using the intraclass correlation coefficient. The calculated interexaminer agreement for pufa (severity of untreated caries) was 95%; for defs (decayed, extracted and filled surfaces), it was 67%.

The American Academy of Pediatric Dentistry (AAPD) defines early childhood caries as the presence of one or more decayed,

missing or filled tooth surfaces in any primary tooth in a child of 71 months of age or younger. The inclusion criteria comprised children with a minimum of one cavity in any primary tooth. Medically compromised children and children whose parents were reluctant to participate in the study were excluded.

The study was undertaken in two stages: a questionnaire survey based on interviews and an intraoral examination. Parent questionnaires adapted from a prior study [12] were modified and piloted and then used in our survey. The indices used during the intraoral examination included defs and pufa.

A face-to-face structured interview in English was conducted by two pediatric dentists with the parents/legal guardians of the 238 children who participated in the study. The interview explored variables related to past and current breast feeding and bottle feeding practices along with baseline socio-demographic data, such as the subjects' age and gender. Specific words in the local language (Tamil) were used when necessary during the interview to elicit better understanding. The feeding practices information included the age of weaning and nocturnal feeding habits. Most of the information gathered was based on a dichotomous response (yes/no), except for the question about the contents of bottle feeding, which was open-ended. The purpose of the questionnaire survey was to identify past and current infant feeding practices that might influence the pattern and severity of current ECC experiences.

The intraoral examination was performed by the same two trained and calibrated dentists under a dental-chair light (Kavo, Germany) using a mouth mirror and an explorer. A knee-to-knee examination position was utilized with very young children. Prior to the examination, the teeth were not cleaned or dried. The 1997 WHO criteria were used to diagnose dental caries in fully and partially erupted teeth. No radiographs were taken, and decay was recorded at the level of restorative treatment need with tactile probing. The defs index was used for each surface examination, and the pufa index was used to assess the severity of oral conditions related to untreated dental caries. Previously trained assistants recorded the findings, and each oral examination was usually completed within 15 min. The findings of the intraoral examination were reported to the parents after the survey, and adequate management was provided thereafter.

defs index

A tooth surface was considered decayed (d) if there was a visible evidence of cavitations; filled (f) if the tooth was restored, and extracted (e) if the tooth was lost due to caries. The following surfaces were examined:

1. For posterior teeth, 5 surfaces were examined and recorded: facial/buccal, lingual, mesial, distal and occlusal.

2. For anterior teeth, 4 surfaces were examined and recorded: facial, lingual/palatal, mesial and distal.

For primary teeth, the maximum defs score is 88 for 20 teeth. Caries affecting one or more anterior (incisors and canine) tooth surfaces (labial, palatal or proximal) were coded as an anterior caries pattern (A-ECC), and caries affecting one or more primary molar tooth surfaces (occlusal, buccal, lingual or proximal) were recorded as a posterior caries pattern (P-ECC).

pufa index

To assess the clinical consequences of untreated dental caries, the codes and criteria for the pufa index was recorded according to the standard procedures developed by Monse at al.,[9] which are as follows:

P/ p: Pulpal involvement is recorded when the opening of the pulp chamber is visible or when the coronal tooth structures have been destroyed by the carious process and only roots or root fragments are left. No probing is performed to diagnose pulpal involvement.

U/u: Ulceration caused by trauma from sharp tooth pieces is recorded when sharp edges of a dislocated tooth with pulpal involvement or root fragments have caused traumatic ulceration of the surrounding soft tissues, e.g., the tongue or buccal mucosa.

F / f: Fistula is scored when a pus-releasing sinus tract related to a tooth with pulpal involvement is present.

A/ a: Abscess is scored when a pus-containing swelling related to a tooth with pulpal involvement is present.

The pufa index was recorded independently from the defs index. Lesions in the vicinity that were not related to a tooth with visible pulpal involvement as a result of caries were not recorded, and only a single score was assigned per tooth. The pufa score per child was calculated in the same cumulative way that was used for the defs index and represents the number of teeth that met the pufa diagnostic criteria, with a score ranging from 0 to 20 (primary dentition).

Statistical analysis

The questionnaire and oral examination forms were manually checked for completeness of data. The collated data thus obtained were entered into a statistical software program (SPSS, Version 16.0, SPSS Inc., Chicago, IL). The data were analyzed using descriptive statistical analysis, ANOVA and chi-square test. Multiple variable analyses were performed using logistic regression to obtain the odds ratio (OR) and 95% confidence interval (CI). We considered p values <0.05 to be statistically significant.

RESULTS

A total of 238 children and their respective parent pair participated in the study. There were 128 boys (53.8%) and 110 girls (46.2%).

Table 1 shows the distribution of children according to feeding practices. In the entire sample (n=238), 115 children were only breast-fed, 14 were only bottle-fed, and 109 children were both bottle- and breast-fed. All the children with nocturnal feeding practices had the habit at the time of the study. The prevalence and the range of caries and untreated dental caries-associated lesions are presented in Table 2. The overall prevalence of untreated dental caries-associated lesions in our sample of ECC-affected children was 72.3%. The abscess component (code a) was the condition most frequently scored. This also indicates that the decayed teeth had progressed to pulpal involvement, resulting in abscess formation.

The mean age of our sample was 54.01 ± 13.45 months. Table 3 depicts the caries presentation across various groups of teeth (anterior caries pattern, posterior caries pattern and the combination of anterior and posterior ECC) and the pufa index by age and feeding practices. There was an increase in the prevalence of ECC patterns and the severity of untreated dental caries-associated lesions with increasing age for all teeth groups. Regarding feeding practices, the consequences of both ECC and untreated caries for the various teeth groups and study sites varied inversely with the current feeding status. In comparison, irrespective of feeding practices, the majority of the children had posterior ECC, and the fewest were affected by ulceration (code u) as a consequence of untreated dental caries. Except for the posterior caries pattern, all other caries patterns and pufa components (code u alone, p<0.05) had a significantly higher prevalence among children with nocturnal feeding practices compared with those who did not have nocturnal feedings (p<0.001).

Binary logistic regression analyses revealed that older age (p<0.05) and nocturnal feeding practices (p<0.001) were significantly associated with pufa scores>0, whereas gender and feeding practices (breast feeding, bottle feeding or both) were not significant.

Table 1. Distribution of the children according to past and current feeding practices (n=238)

Feeding practices	Males (n=128) n (%)	Females (n=110) n (%)	Total (n=238) n (%)
Breast feeding practices			
Currently breast fed	3 (2.3)	1 (0.9)	4 (1.7)
Never breast fed	6 (4.7)	8 (7.3)	14 (5.9)
Breast feeding weaned	119 (93.0)	101 (91.8)	220 (92.4)
Nocturnal breast feeding	32 (25.0)	20 (18.2)	52 (21.8)
Bottle feeding practices			
Currently bottle fed	13 (10.2)	13 (11.8)	26 (10.9)
Never bottle fed	67 (52.3)	48 (43.6)	115 (48.3)
Bottle feeding weaned	48 (20.2)	49 (20.6)	97 (40.8)
Nocturnal bottle feeding	40 (31.3)	36 (32.7)	76 (31.9)
Combination(Breast fed+Bottle fed)	55 (43.0)	54 (49.1)	109 (45.8)

Table 2. Mean and standard deviation (SD) and range of the defs and pufa index scores in children with ECC

Index	n (%)	Mean ±SD	Range
d	235 (98.7)	4.14±1.97	0-15
e	70 (29.4)	0.32±0.53	0-2
f	34 (14.3)	0.21±0.60	0-4
defs	238 (100)	4.68±1.93	1-15
p	83 (34.9)	0.58±1.01	0-6
u	50 (21.0)	0.24±0.49	0-2
f	95 (39.9)	0.58±0.84	0-4
a	98 (41.2)	0.71±1.04	0-6
pufa	172 (72.3)	2.08±2.30	0-15

It was evident that older children had higher odds of having pufa scores>0 (OR 3.30 and 95% CI 1.43-7.60) and that those without nocturnal feeding practices had lower odds of having pufa scores>0 (OR 0.11 and 95% CI 0.05-0.23; Table 4).

The results showed that the mean value was highest in children who were exclusively bottle fed (2.43±2.56), followed by the children who were both bottle and breast fed (2.08±2.36); the lowest mean value was observed in children who were only breast fed (2.07±2.24). No statistically significant association in relation to pufa score and feeding practices was observed among the three groups (p=0.85).

As Figure 1 shows, the tooth-specific pattern of caries varied with regard to nocturnal feeding practices. There were no caries evident in the mandibular incisor region. However, the caries rate was highest among those with nocturnal feeding in cases of maxillary anterior and mandibular canine involvement. Moreover, nocturnal feeding affected the maxillary and mandibular second molars more than the first molars compared with children who did not have nocturnal feeding.

The frequency distribution of the number of untreated dental caries lesions according to the presence or absence of nocturnal feeding practices is depicted in Figure 2. In our sample, nocturnal feeding resulted in a maximum of 15 untreated caries lesions; among children without nocturnal feeding, however, the occurrence of untreated caries lesions was lower, with a maximum of only 5 lesions.

DISCUSSION

This is the first study in the Indian population to evaluate the caries pattern in children with ECC and its relationship with their feeding practices. In the present study, the children with nocturnal feeding practices experienced a higher prevalence of untreated caries lesions and significantly more anterior and posterior caries. The children who were breast fed and weaned and those who were only bottle fed also had higher prevalence of posterior caries. Studies have reported the association between prolonged breastfeeding and ECC.[13,14] However, studies of ECC and associated factors require information obtained from mothers regarding their child-rearing practices, which may not be totally reliable. Mothers who have some knowledge about the potential risk factors of ECC may not be keen to disclose that they practiced risk-bearing habits, particularly if their child suffers from ECC. Consequently, there may be a bias of solicited information.[15]

Mutans streptococci are the principal bacteria isolated from children with ECC.[16] These organisms are usually first detected when the first primary teeth emerge in the oral cavity.[17] The initial acquisition of mutans streptococci at the median age of 26 months coincides with the emergence of primary molars; children with improper feeding practices have earlier colonization and a higher risk of caries.[18] Among diverse populations, the proportion of infants with *mutans streptococci* detected ranges from <30% in predentate infants to over 80% in 24-month-old infants, with disparately higher acquisition among infants of lower socio-economic status.[19-22] In the present study, there was an increase in the ECC patterns and the severity of untreated dental caries with increased age for all teeth groups. It has been reported that the degree of infection with mutans streptococci increases with age.[17]

Table 3. Any caries experience, anterior caries pattern (A-ECC), posterior caries pattern (P-ECC), both quadrants, and severity of untreated caries by age and feeding practices

	A-ECC % (n)	P- ECC % (n)	Both A &P (ECC) % (n)	pufa>0 % (n)	p % (n)	u %(n)	f % (n)	a % (n)
Age (months)								
6-36	27.6 (42)	20.3 (47)	26.2 (38)	19.2 (33)	22.9 (19)	14.0 (7)	17.9 (17)	19.4 (19)
37-72	72.4 (110)*	79.7 (184)*	73.8 (107)*	80.8 (139)	77.1 (64)	86.0 (43)	82.1 (78)	80.6 (79)
Feeding practices								
Breast feeding: yes	2.6 (4)	0.9 (2)	1.4 (2)	0.6 (1)	0.0 (0)	0.0 (0)	1.1 (1)	1.0 (1)
Breast feeding: never	7.9 (12)	61 (14)	8.3 (12)	5.2 (9)	6.0 (5)	4.0 (2)	7.4 (7)	7.1 (7)
Breast feeding: weaned	89.5 (136)	93.1 (215)**	94.2 (162)	94.0 (78)	96.0 (48)	91.6 (87)	91.8 (90)	90.3 (131)
Bottle feeding: yes	13.8 (21)	10.4 (24)	13.1 (19)	11.0 (19)	13.3 (11)	6.0 (3)	11.6 (11)	10.2 (10)
Bottle feeding: never	48.7 (74)	48.5 (112)	49.0 (71)	48.3 (83)	48.2 (40)	54.0 (27)	44.2 (42)	48.0 (47)
Bottle feeding: weaned	37.5 (57)	41.1 (95)	40.7 (70)	38.6 (32)	40.0 (20)	44.2 (42)	41.8 (41)	37.9 (55)
Combination(Breast fed + Bottle fed)	43.4 (66)	45.5 (105)	42.8 (62)	46.5 (80)	45.8 (38)	42.0 (21)	48.4 (46)	44.9 (44)
Nocturnal feeding§: Yes	63.8 (97)	52.8 (122)	62.8 (91)	65.7 (113)	85.5 (71)	72.0 (36)	68.4 (65)	72.4 (71)
Nocturnal feeding§: No	36.2 (55)**	47.2 (109)	37.2 (54)**	34.3 (59)**	14.5 (12)**	28.0 (14)*	31.6 (30)**	27.6 (27)**

Chi-square test *P<0.05; **P<0.001

§Nocturnal feeding practices: at the time of the study

Table 4. Distribution of pufa score by child's age, gender and feeding practices

Variables	Categories	n (%)	Odds ratio (95% CI)
Child's age	6-36 months	51 (21.4)	1
	37-72 months	187 (78.6)*	3.299 (1.432-7.599)
Gender	Male	128 (53.8)	1
	Female	110 (46.2)	0.990 (0.527-1.862)
Feeding practices	Breast feeding	115 (48.3)	1
	Bottle feeding	14 (5.9)	1.001 (0.517-1.940)
	Combination(Breast fed+ Bottle fed)	109 (45.8)	0.921 (0.251- 3.380)
Nocturnal feeding	Yes	128 (53.8)	1
	No	110 (46.2)**	0.112 (0.053-0.234)

*P<0.05; **P<0.001

Figure 1. Frequency of distribution for caries according to tooth type and nocturnal feeding practices
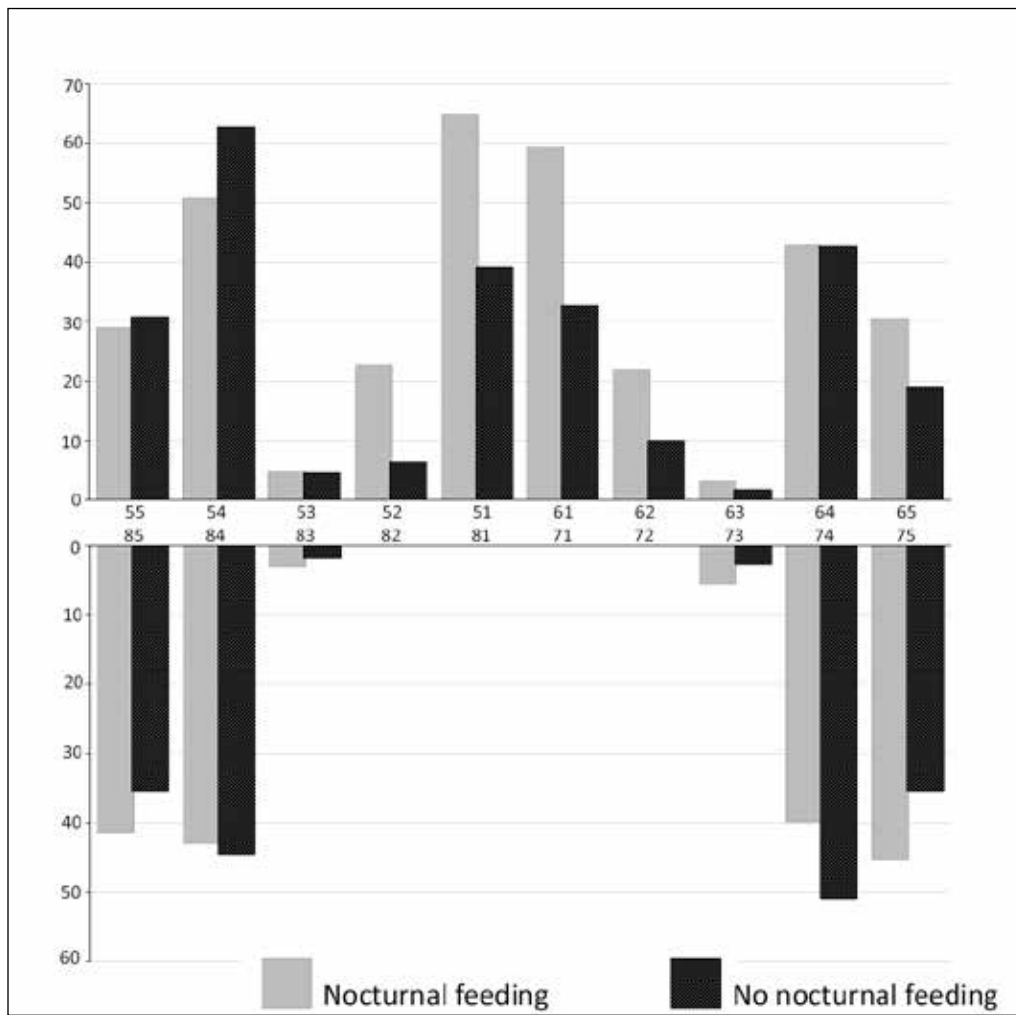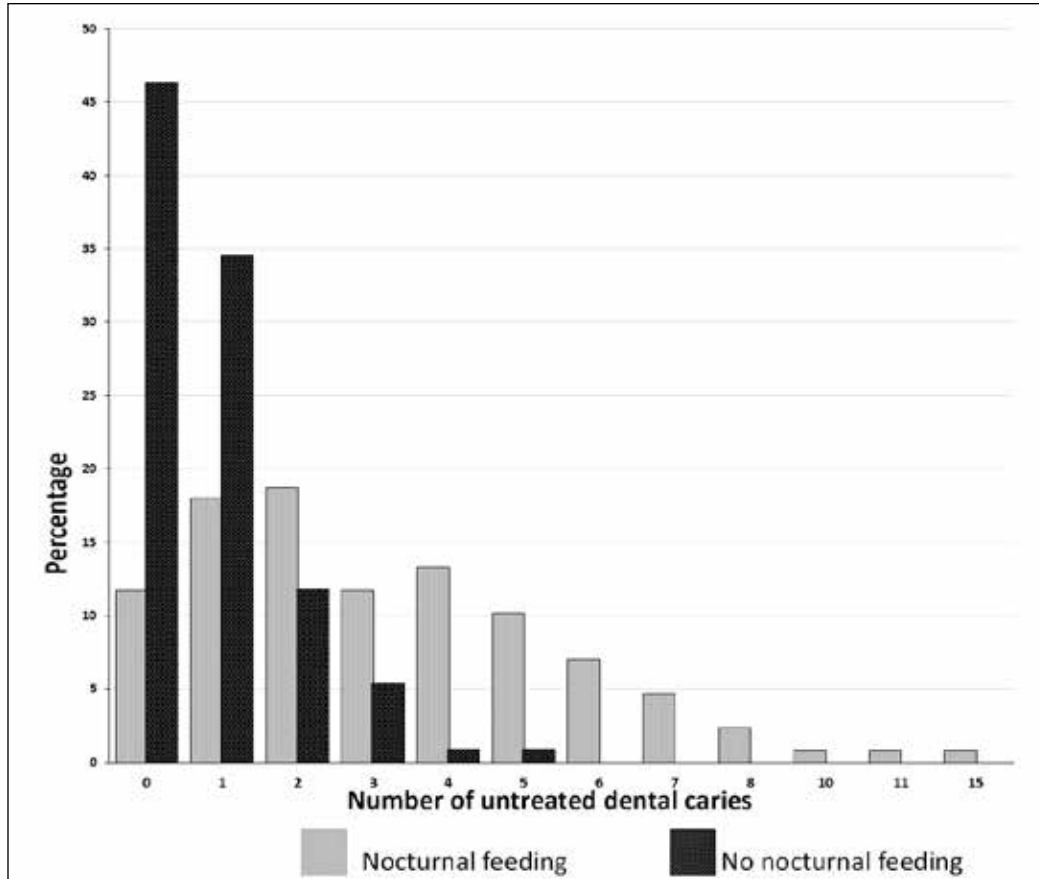
Figure 2. Distribution of the number of untreated caries lesions according nocturnal feeding practices

The availability of fermentable carbohydrates over a prolonged period of time is the most significant factor in shifting the re-/demineralization equilibrium toward demineralization.[23] The finding that nocturnal, not daytime, feeding habits increase the risk that a child will develop ECC is in agreement with the theory that a reduced nocturnal salivary flow results in higher levels of lactose in the resting saliva and dental plaque for longer than would be expected during the day.[24] Thus, a shift to demineralization is likely compounded during the night because of inadequate defense mechanisms caused by reduced nocturnal salivary flow. It has been reported that children sleeping with a bottle of milk or other sugary drinks do not always develop caries and that frequent exposure to a cariogenic diet and early infection with cariogenic bacteria are the main reasons for tooth demineralization in young children.[25] Thus, we believe that the higher prevalence of anterior and posterior caries in the present report may be related not just to bottle- or breast-feeding practices but may also have been influenced by other unfavorable factors, such as the duration of weaning, a low level of fluoride use, inappropriate oral hygiene practices, frequent exposure to a cariogenic diet and the family's socioeconomic status.[26]

Our study also revealed that the children who were exclusively breast fed had a higher prevalence of posterior caries than anterior caries. The development of a maxillary anterior caries pattern was strongly associated with mutans streptococci infection.[27] IgA related to mutans streptococci is found in high concentrations in breast milk.[28] These secretory immunoglobulins inhibit bacterial adherence or agglutination and the neutralization of bacterial enzymes.[29] This may have a protective effect on anterior caries, which supports our finding of a lower prevalence of anterior caries in breast-fed children. It has been suggested that breast-fed children have a higher number of food intake periods per day compared with non-breast-fed children, which contribute to the development of ECC.[30] It should be noted that human milk is not considered to be cariogenic under normal dietary conditions, but repeated and prolonged exposure can result in a decrease in plaque pH and consequent enamel decalcification.[31]

To the best of the authors' knowledge, this is the first study to report pufa and defs index information for children with ECC and the relationship between these index scores and feeding practices. The pufa index was used to determine the severity of oral conditions related to untreated caries. pufa is a severity index that defines four different clinical stages of advanced caries, providing a real-life view of the prevailing and often ignored oral condition. Thus, the pufa index will provide health planners with relevant information that is complementary to the dmft. The mean defs scores for all three types of feeding practices indicate only the surfaces affected with caries and not the extent of the caries involvement (pulpal exposure and dental abscess). This limitation has been overcome by recording pufa index scores. The highest mean pufa score was observed for the group of children who were bottle fed (2.43±2.56) compared with the children who were exclusively breast fed (2.07±2.24) and those who were both breast and bottle fed (2.08±2.36), indicating that at least two teeth

in each subject might have caries-related pulpal involvement, abscess, fistula or ulceration. However, there was no statistically significant difference between feeding practices and mean defs/pufa score. Overall, 72.3% of the children in our study had signs of odontogenic infection that warranted appropriate treatment, such as tooth extractions, restorations or endodontic treatment.

The coexistence of social, cultural, ethnic, behavioral and economic circumstances in infinite combinations modifies the etiopathogenesis of ECC. It has also been emphasized that people in developing countries who develop ECC suffer the same deprivations as people living in poor economic circumstances in developed countries, but the way of life in developing countries is much less complex.[32] Consequently, studies in such environments may lead to interventions that may prove to be successful in the long run. Hence, the present study is important in this regard.

CONCLUSIONS

1. The prevalence of caries in posterior teeth was higher than that in anterior teeth for all three types of feeding practices.

2. Higher percentages of caries and severity of untreated caries were observed in the children with nocturnal feeding practices.

3. The severity of untreated caries based on the pufa index revealed that children who were exclusively bottle fed were at a higher risk compared with children who had other feeding practices.

More studies on ECC are needed to assess the interplay of various risk factors in communities where it is customary to breast feed for prolonged periods and where nocturnal feeding with sweetened beverages in bottles or with breast milk is highly prevalent. Moreover, future studies need to evaluate additional information, such as the duration and frequency of feeding practices, to draw definite conclusions about the caries patterns of children affected with ECC and their control groups.

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