DENTAL CARIES AND RELATED ORAL HEALTH FACTORS AMONG 9 TO 18 MONTH OLD THAI CHILDREN

Palinee Detsomboonrat and Pagaporn Pantuwadee Pisarnturakit

Department of Community Dentistry, Chulalongkorn University, Bangkok, Thailand

Abstract. Dental caries can occur as soon as the first tooth erupts. We studied the caries prevalence and related risk factors among children aged 9-18 months in U Thong District, Suphan Buri Province, Thailand. A total of 151 children, whose primary caregivers were willing to participate in this study, were evaluated for decayed, missing, and filled tooth surfaces (dmfs). Questionnaires were given to the primary caregivers of the study subjects to ascertain their socio-economic status, oral hygiene habits, and child-feeding habits. The Mann-Whitney *U* and Kruskal-Wallis tests were used to evaluate bivariate outcome data. Hierarchical multiple regression analysis was used to determine variables predictive of dental caries in the studied children. The prevalence of dental caries among the 151 subjects was 32.5%; 15.9% had at least one cavity (cavitated caries) and 16.6% had white lesions (non-cavitated caries). The mean dmfs score was 2.83±6.48. Significant associations were seen between the dmfs score and the number of erupted teeth *(p*<0.001*)* and toothpaste usage *(p*<0.01*)*. Hierarchical multiple regression analysis revealed four factors significantly associated with caries: number of erupted teeth, which had the highest Beta value (β=0.35, *p*<0.01), nighttime bottle feeding (β=0.17, *p*<0.05), frequency of drinking sweetened milk (β=0.17-0.18, *p*<0.05) and falling asleep with a bottle in the mouth (β=0.18, *p*<0.05). Nighttime bottle feeding, frequency of drinking sweetened milk and falling asleep with a bottle in the mouth were important caries risk factors and the number of erupted teeth was a strong caries risk predictor. Dentists should educate caregivers about these risk factors.

Keywords: hierarchical multiple regression, dental caries, oral health related factors, young children

INTRODUCTION

Early childhood caries (ECC) is a significant dental problem affecting young children in both developed and developing countries, especially in low socio-economic areas (De Grauwe *et al*, 2004). In Thailand, the prevalence of dental caries in young children has been high during the past two decades (51.7%-66.5%) (Dental Health Division, 2012b). Dental caries can occur in young children as early as when the first tooth erupts (Vachirarojpisan *et al*, 2004; Thitasomakul *et al*, 2009). Studies from both rural and urban Thailand have reported a high prevalence of ECC (Vachirarojpisan *et al*, 2004; Thanakanjanaphakdee and Triratvorakul, 2010; Thitasomakul *et al*, 2006, 2009; Sutthavong *et al*, 2010); although the caries prevalence among 3-year-old Thai

Correspondence: Pagaporn Pantuwadee Pisarnturakit, Department of Community Dentistry, Faculty of Dentistry, Chulalongkorn University, 34 Henri-Dunant Road, Pathum Wan, Bangkok 10330, Thailand.
Tel: +66 (0) 2218 8597; Fax: +66 (0) 2218 8545
E-mail: pagaporn.p@chula.ac.th

children decreased slightly between the sixth and the seventh Thailand National Oral Health Surveys; the majority of Thai children living in rural areas have more dental caries than those in urban areas (Dental Health Division, 2008; 2012a).

ECC is a multi-factorial disease. The causes of ECC include microorganisms attacking the tooth surface, impaired host resistance, infant feeding habits, diet, oral hygiene, use of fluoride, and socioeconomic factors (Veerkamp and Weerheijm, 1995; Brice *et al*, 1996; Milgrom, 1998; Seow, 1998; Reisine and Psoter, 2001; Vanobbergen *et al*, 2001; Jose and King, 2003; Harris *et al*, 2004; Vachirarojpisan *et al*, 2004; Thitasomakul *et al*, 2009; Sutthavong *et al*, 2010). There are few studies of the prevalence and causative factors of ECC among children aged less than 2 years. Therefore, we aimed to investigate the prevalence of dental caries among Thai children aged 9-18-months and identify the related risk factors.

MATERIALS AND METHODS

Study area characteristics

U Thong Sub-district, U Thong District, Suphan Buri Province, Thailand was selected for the study because the prevalence and severity of dental caries there is higher than the rest of the country (Dental Health Division, 2012a). In 2012, the caries prevalence of 3-year-old children in U Thong District was 69.7% with an average decayed, missing, and filled teeth (dmft) score of 4.3 (Suphan Buri Provincial Public Health Office, 2012a). Poor child rearing practices are common in this area with parents allowing their children to consume highly sugary foods and brushing their child's teeth less frequently (Dental Health Division, 2012a). The U Thong Sub-district has a population of 19,412 people and the water is not fluoridated (Thailand Information Center, 2012). The drinking water in this area contains 0.1 to 0.5 ppm fluoride (Suphan Buri Provincial Public Health Office, 2012b). Dental care for young children is available at a government hospital, and is provided by one pediatric dentist and one dental nurse.

Subjects

The protocols used in the present study were approved by the Ethics Committee, Faculty of Dentistry, Chulalongkorn University. Primary caregivers of the study subjects were informed about the program and invited to enroll. The caregivers were asked to bring their children in for dental examinations and provide information about their child rearing practices. Written informed consent was obtained from each primary caregiver. The study population was comprised of 151 children in the U Thong Sub-district born from December 2011-September 2012 (aged 9-18-months).

Clinical examination

Oral examinations were performed in a knee-to-knee position by a pediatric dentist using a ball-ended probe and a mouth mirror under natural light. The classification of dental findings was modified from Warren *et al* (2002): an unerupted tooth (U), a normal enamel surface (S), demineralization but no loss of enamel structure (d1), a lesion with loss of tooth structure (d2), a filled surface without evidence of secondary caries (f) and a missing tooth due to caries (m). The severity of the caries was quantified by the decayed, missing, and filled surfaces (dmfs) score.

The child's oral health/hygiene was determined using the Debris Index (Greene and Vermillion, 1964) and Gingival Index (Loe, 1967). The Debris Index is scored on the labial surfaces of the upper

right incisor, lower left incisor, upper right first molar and upper left first molar, and the lingual surfaces of the lower right first molar and lower left first molar with a scale of 0 to 3 (Table 1). The Debris Index is obtained by the sum of the debris score for all teeth, divided by the number of examined surfaces. The Gingival Index is one of the most commonly used indices for assessing the status of gingival health. Labial gingival tissue of the upper incisor is given a score of 0 to 3 (Table 2). The subjects' oral hygiene was evaluated by one pediatric dentist. The intra-examiner reliability was determined by re-examining 10% of the subjects; the kappa values for the caries examination, Debris Index, and Gingival Index were 0.87, 0.61 and 0.89, respectively.

The interview

The primary caregiver's child oral health care practices were determined using questionnaire-guided interviews. The primary caregiver's information (gender, age, relationship to the child, occupation, marital status, education, and family income) and the child's information (gender, age, birth order, medical history and medications) were recorded. The interview focused on the primary caregiver's behavior related to ECC: when they began cleaning the child's teeth, method of cleaning, time of day and frequency of teeth cleaning, type and amount of toothpaste used, type and frequency of milk feeding, type of sweetener used in the bottle, type and frequency of snacks between meals, age of starting supplementary food, type of drinking water, water sipping after milk feeding, and putting the child to bed with a bottle in the mouth.

Statistical analysis

The data were analyzed using the Statistical Package for Social Science, version 17.0 (IBM, Armonk, NY). Descriptive statistics were used for characteristics of the children and their primary caregivers. The Mann-Whitney *U* and Kruskal-Wallis tests were used because the dmfs data were not normally distributed. Hierarchical multiple regression analysis was used to determine the risk factors related to dental caries. The variables used for the model were: the child's age, number of erupted teeth, maternal education level, family income, frequency of brushing (per week), nighttime bottle feeding, frequency of drinking sweetened milk (per day), number of times falling asleep with a bottle in the mouth (per week), snacking between meals (per day) and fluoride supplement intake. The correlations and associations between independent variables were assessed with the correlation coefficient or cross-tabulation for preliminary analyses. Along with nominal variables, dummy variables were added to correctly analyze attribute variables before multiple regression analysis. The number of dummy variables was equal to the number of categories in that variable minus one.

RESULTS

Characteristics of the children and primary caregivers

Of the 151 subjects in our study 52.3% were boys. The average subject age was 16.1 ± 4.10 months. Seventy-one point five percent of the primary caregivers were parents, 21.9% were grandparents and 6.6% were other relatives. The mean age of the primary caregivers was 32.5±12.6 years. Sixty-three point six percent of the primary caregivers had completed high school or vocational school and 36.4% had a primary school education. Thirty-eight point four percent of mothers were

Table 1
The Debris Index of Greene and Vermillion.

0 = No debris or stains present.
1 = Soft debris covering no more than one third of the tooth surface being examined or the presence of extrinsic stains without debris, regardless of the surface area covered.
2 = Soft debris covering more than one-third but not more than two-thirds of the exposed tooth surface.
3 = Soft debris covering more than two-thirds of the exposed tooth surface.

Table 2
The Gingival Index of Löe and Silness.

0 = Normal gingiva.
1 = Mild inflammation - slight change in color, slight edema. No bleeding on probing.
2 = Moderate inflammation - redness, edema and glazing. Bleeding on probing.
3 = Severe inflammation - marked redness and edema. Ulceration. Tendency to spontaneous bleeding

housewives and 61.6% were employed. Thirty-five point eight percent of subjects came from a family with a total parental income of <10,000 Baht (USD307.90)/ month and 33.1% came from a family with a total parental income of 10,000-14,999 Baht (USD307.90-461.82)/month. The average family monthly income in Thailand during 2011 was 23,236 Baht (USD715.44)/ month (National Statistical Office, 2011) (Table 3).

Dental caries and oral hygiene status

The prevalence of dental caries among the 151 subjects was 32.5% (15.9% cavitated and 16.6% non-cavitated). The mean and standard deviation for the dmfs scores (including non-cavitated lesions) was 2.83±6.48. Sixty-two point three percent had no debris on their teeth. The mean Debris Index was 0.33±0.55. (Debris Index range was 1-3). Twenty-three point eight percent of subjects had a slight change in gingival color and slight gingival edema. Dental caries was found on the first tooth that had erupted in an 11-month old child. She was frequently fed with snacks, frequently fell asleep with a bottle in her mouth, and her teeth had never been brushed before.

Child rearing and oral health behavior

In the study community, most of the subjects (68.7%) were bottle-fed, 8.7% were exclusively breast-fed and 22.6% were both breast- and bottle-fed. The frequency of breast feeding (6-8 times a day) was higher than that of bottle feeding (3 times a day). Fifty-two percent of the subjects fell asleep with a bottle in their mouth and 86.1% drank from a bottle 2–3 times per night. Thirty-nine percent of subjects consumed fruit juice with their bottle.

Consumption of snacks, sugary drinks and foods was common among subjects. The most popular foods were packaged carbohydrate snacks and yogurt. Other sugary foods consumed included candy, soft drinks and Thai desserts. Eighty point three percent of subjects ate these types of foods.

Table 3
Associations between dental dmfs score and related factors (*N*=151).

Factors	*n*	%	Mean	SD	*p*-value
Age of primary caregivers Mean, (SD)	32.5 (12.6)				
Age of children, Mean (SD)	16.1 (4.10)				
Gender of subject					
Boy	79	52.3	3.14	6.34	
Girl	72	47.7	2.50	6.65	0.388
Relationship of caregiver to subject					
Parent	108	71.5	3.07	6.85	
Grandparent	33	21.9	2.58	6.16	
Relative	10	6.6	1.10	1.45	0.926
Marital status of caregiver					
Married	140	92.7	2.85	6.62	
Single or divorced	11	7.3	2.64	4.60	0.431
Maternal education level					
Primary school or less	55	36.4	2.62	5.57	
High school or greater	96	63.6	2.96	6.97	0.884
Maternal occupation					
Housewife	58	38.4	3.22	7.57	
Working	93	61.6	2.59	5.72	0.870
Family income/month					
≤10,000 Baht	54	35.8	3.33	7.41	
10,000 - 14,999 Baht	50	33.1	3.84	7.60	
>15,000 Baht	47	31.1	1.19	2.80	0.307
Child rearing experience of caregiver					
Yes	115	85.2	2.65	5.24	
No	20	14.8	2.56	6.30	0.864
Erupted teeth					
≤8 teeth	90	59.6	0.86	3.58	
≥9 teeth	61	40.4	5.75	8.45	0.000[b]
Type of feeding					
Breast feeding	13	8.7	1.54	4.27	
Bottle feeding	103	68.7	3.21	6.90	
Mixed breast and bottle feeding	34	22.6	2.26	5.92	0.404
Number of time falling asleep with a bottle in the mouth per week					
Never	72	47.7	2.26	5.09	
≤3 times	18	11.9	1.39	4.00	
≥4 times	61	40.4	3.93	8.22	0.615
Night-time bottle feeding					
Yes	130	86.1	3.14	6.89	
No	21	13.9	0.95	1.93	0.292
Frequency of brushing per week					
Never	42	27.8	1.52	3.93	
≤2	7	4.6	3.57	6.45	
≥3	102	67.6	3.32	7.25	0.167

Table 3 (Continued).

Factors	*n*	%	Mean	SD	*p*-value
Frequency of brushing per day					
Never or some days	66	43.7	2.64	5.61	
1 time	30	19.9	2.70	6.66	
≥2 times	55	36.4	3.15	7.40	0.905
Fluoride supplement intake					
No	127	84.1	3.03	6.77	
Yes	24	15.9	1.79	4.57	0.340
Toothpaste use					
None	37	24.5	0.95	2.97	
Children's toothpaste	68	45.1	4.71	8.54	
Adult toothpaste	4	2.7	1.50	2.38	0.008[a]
Number of times snacking between meals per day					
Never or rarely	20	13.6	3.35	7.67	
≤3	106	72.1	2.70	6.59	
≥4	21	14.3	3.10	5.30	0.358
Good child-rearing practice					
Yes	4	2.70	2.83	6.55	
No	147	97.3	3.00	3.46	0.435

dmfs: decayed, missing and filled surfaces.
Statistical significance with Mann-Whitney *U* test and Kruskal Wallis test: [a]$p<0.01$, [b]$p<0.001$.

Twenty seven point eight percent of subjects had never had their teeth brushed at all, and 24.5% of subjects had their teeth brushed without toothpaste. Forty-five point one percent of subjects had their teeth brushed using children's toothpaste and 2.7% used adult toothpaste. Sixty-two point three percent of subjects had their teeth brushed by their caregivers in the morning and 30.5% had their teeth brushed at bedtime.

Bivariate analysis of dmfs score and oral health related factors

The results of bivariate analysis of the dmfs scores and other variables are shown in Table 3. The number of erupted teeth and use of toothpaste were significantly associated with the dmfs score ($p<0.001$ and $p<0.01$, respectively). Subjects with at least 9 erupted teeth and those using children's toothpaste had higher dmfs scores. Subjects who were not allowed to fall asleep with a bottle in their mouths, who did not drink from a bottle at night, who used fluoride toothpaste, who had their teeth brushed at least twice a day and who consumed between-meal snacks less than 3 times a day, were classified as being raised using good child-rearing practices. Subjects who were raised using good child-rearing practices had non-significantly ($p=0.435$) lower dmfs scores than children who were not.

Multiple regression analysis of dmfs scores and oral health related factors

Hierarchical multiple regression analysis was used to investigate the factors associated with ECC, such as socio-

Table 4
Descriptive statistics and correlations with variables (N=151).

Variables	dmfs	Age	Erupted teeth
dmfs	1.00		
Age	0.22[a]	1.00	
Erupted teeth	0.35[a]	0.76[a]	1.00
Means	2.83	16.11	8.93
Standard deviation	6.48	4.13	4.67

dmfs: decayed, missing and filled surfaces.
Statistical significance with hierarchical multiple regression analysis: [a]p<0.01.

economic factors, infant feeding habits, dietary habits, consumption of sugary foods, frequency of tooth brushing and use of fluoride. Preliminary analyses were performed to ensure there were no violations of the assumptions of normality, linearity or homoscedasticity. The correlations are shown in Table 4. All correlations were weak, indicating multicollinearity was unlikely to be a problem (Tabachnick and Fidell, 2007). Age, number of erupted teeth, frequency of drinking sweetened milk and snacking between meals were significantly associated with the dmfs score, although the correlation coefficients ranged from weak to moderately strong (-0.03-0.35; p<0.01) (data not shown). These correlations indicate their suitability for multiple linear regression analysis.

In the first step of hierarchical multiple regression analysis, four predictors were entered: age, number of erupted teeth, maternal education level and family income. This model was statistically significant [F (6, 144) = 4.22; p<0.001] and explained 15% of the variance in the dmfs scores (Table 5). After entering the 6 additional predictors into the model in Step 2, the model explained 31% of the variance in the dmfs scores [F (19, 131) = 3.06; p<0.001].

The introduction of an additional six factors (frequency of brushing per week, nighttime bottle feeding, frequency of drinking sweetened milk per day, number of times falling asleep with a bottle in the mouth per week, number of times snacking between meals times per day, and fluoride supplementation) explained an additional 16% of variance in the dmfs scores after controlling for the child's age, number of erupted teeth, maternal education level, and family income [R^2 Change = 0.16; F (13, 131) = 2.30; p<0.01]. Four of the ten predictors were significantly associated with dmfs scores in the final model: number of erupted teeth, which had a higher Beta value (β=0.35, p<0.01) than nighttime bottle feeding (β=0.17, p<0.05), frequency of drinking sweetened milk (β=0.17-0.18, p<0.05) or falling asleep with a bottle in the mouth (β=0.18, p<0.05).

DISCUSSION

The prevalence of ECC among children aged 9-18 months in this study was high. Only a few studies have evaluated this young age group in Thailand (Thanakanjanaphakdee and Triratvorakul, 2010; Thitasomakul *et al*, 2006; Vachirarojpisan *et al*, 2004). The mean dmfs score in our

Table 5
Hierarchical Regression Analysis Model for dental caries (dmfs).

	R	R^2	R^2 Change	B	SE	β	t
Step 1	0.39	0.15[c]					
Age				-0.10	0.19	-0.06	-0.54
Number of erupted teeth				0.54	0.16	0.39	3.30[b]
Maternal education level				0.17	1.07	0.01	0.16
Family income							
<10,000 Baht/month				0.19	1.20	0.01	0.16
10,000-14,999 Baht/month				-2.13	1.40	-0.13	-1.53
≥15,000 Baht/month				-2.41	1.74	-0.12	-1.39
Step 2	0.56	0.31[c]	0.16[b]				
Age				0.03	0.19	0.02	0.18
Erupted teeth				0.49	0.16	0.35	2.99[b]
Maternal education level				-0.01	1.04	-0.00	-0.01
Family income							
<10,000 Baht/month				-0.33	1.19	-0.02	-0.28
10,000-14,999 Baht/month				-2.60	1.40	-0.16	-1.86
≥15,000 Baht/month				-2.68	1.71	-0.13	-1.57
Frequency of brushing							
<3 times/week				0.49	2.45	0.02	0.20
≥3 times/week				-1.03	1.74	-0.06	-0.59
Every day				-0.57	1.25	-0.04	-0.45
Nighttime bottle feeding				3.23	1.48	0.17	2.18[a]
Frequency of drinking sweetened milk							
<3 times/day				2.94	1.37	0.17	2.15[a]
3-5 times/day				4.29	1.93	0.18	2.22[a]
6-8 times/day				3.77	1.77	0.17	2.13[a]
Falling asleep with bottle in the mouth							
<4 times/week				-0.49	1.38	-0.03	-0.35
4-6 times/week				4.44	1.96	0.18	2.27[a]
Everyday				2.69	1.23	0.18	2.19[a]
Snacking between meals							
<4 times/day				-0.91	1.42	-0.07	-0.64
≥4 times/day				-2.25	1.88	-0.12	-1.20
Fluoride supplementation				-1.05	1.38	-0.06	-0.76

Statistical significance with hierarchical multiple regression: [a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$.
R^2, amount of variance explained by IVs; R^2 Change, additional variance in DV; B, Unstandardized coefficient; β, Standardized coefficient (values for each variable are converted to the same scale so they can be compared); SE, Standard error; t, estimated coefficient (B) divided by its own SE. If $t < 2$ the IV does not belong to the model.

study (2.83±6.48) was similar to studies from the same aged children in Khon Kaen Thailand (dmfs = 2.96) (Thanakanjanaphakdee and Triratvorakul, 2010) and among 18-month old children from southern Thailand (dmfs = 2.8±2.7) (Thitasomakul *et al*, 2006). However, our findings were somewhat higher than a study of Native American children aged 16 months (dmfs = 1.57) (Warren *et al*, 2012). The differences may be due to different ethnic, cultural or social influences (Adair *et al*, 2004; Touger-Decker and van Loveren, 2003). Our results show the risk of developing early childhood caries starts during the first year of life and is worsened by poor child-rearing practices (Marino *et al*, 1989; Veerkamp and Weerheijm, 1995; Harris *et al*, 2004; Vachirarojpisan *et al*, 2004; Thitasomakul *et al*, 2006; 2009; Sutthavong *et al*, 2010).

The children in our study had a high frequency of breast feeding (6-8 times a day and 2-3 times a night). This habit results in the accumulation of milk on the tooth surfaces, especially on the upper incisors where there is low salivary flow. This could be a reason for the level of caries among children exclusively breast-fed compared to bottle-fed only children. Studies have found the frequency of milk intake is the most important determinant for ECC development, irrespective of whether the child was breast-fed or bottle-fed (Marino *et al*, 1989; Williams and Hargreaves, 1990; Vanobbergen *et al*, 2001; Thitasomakul *et al*, 2009). Due to concerns about insufficient nutrition and mental health, parents and caregivers often give their children excessive quantities of milk frequently. Caregivers often sweeten the milk or yogurt to stimulate their child's appetite (Wigen and Wang, 2012).

Cariogenic foods have become readily available even in remote areas of Thailand. Children are exposed earlier and more frequently to cariogenic foods than was previously possible. The easy access to convenience stores in villages promotes cariogenic food consumption among young children. The earliest consumption of cariogenic food in our study was in a child aged less than one year. Previous studies have found having sugary snacks and soft drinks at an early age significantly increases the incidence of ECC (Touger-Decker and van Loveren, 2003; Vachirarojpisan *et al*, 2004; Thitasomakul *et al*, 2009). Our study found packaged carbohydrate snacks and cookies are popular among children with ECC. Parents often used snacks or sweets as a reward or a tool to control their child's behavior.

In our study, 27.8% of primary caregivers had never brushed their child's teeth at all and 24.5% of caregivers brushed their child's teeth without toothpaste. Brushing without toothpaste may come from the concern about the adverse effects of excess fluoride due to the child swallowing the toothpaste. Cochran reviews about the risk of fluorosis due to the use of fluoride toothpaste in children under 12 months old have inconclusive results (Wong *et al*, 2010; 2011). However, several studies have demonstrated the benefit of using fluoride toothpaste in younger children (Wong *et al*, 2011) by reversing or arresting the demineralization process due to the effects of fluoride (Featherstone *et al*, 1981). The American Academy of Pediatric Dentistry recommends beginning the use of fluoridated toothpaste when the first tooth erupts (American Academy of Pediatric Dentistry, 2012). The possibility of adverse effects associated with the use of fluoride toothpaste in young children should be investigated in future studies to determine the appropriate balance between the beneficial and harmful effects

of fluoride.

Hierarchical multiple regression analysis demonstrated the number of erupted teeth had the greatest association with the dmfs score. Children with more erupted teeth had a higher risk for ECC than children with fewer erupted teeth, possibly because the greater number of teeth increases the difficulty in brushing them in younger children. The frequency of drinking sweetened milk, falling asleep with a bottle in the mouth, and nighttime feeding were also factors associated with ECC in our study. Our findings are similar to other studies who found a significantly greater risk of ECC among children who drank from a bottle at bedtime depending on the contents of the bottle (Reisine and Psoter, 2001; Subsandee *et al*, 2008). Our findings are also similar to those of Subsundee *et al* (2008) who found most caregivers gave their child a bottle to drink at nap time to help the child fall asleep because it was the easiest way to stop the child from crying (Subsandee *et al*, 2008). A study about bottle use behavior among Thai preschool children found most Thai children were weaned at 2.8±0.9 years old (Subsandee *et al*, 2008). The most common reason for being unable to wean was the refusal of the child to wean and increased consumption of milk or fruit juice during bottle feeding (Subsandee *et al*, 2008). Concern about malnutrition and poor mental health were reasons found in another study for not weaning a child from the bottle (Subsandee *et al*, 2008). Besides milk, fruit juice was the most popular liquid put in the bottle in our study. Fruit juice is cariogenic due to its high sugar content and it can easily be consumed from a bottle (Dennison, 1996; Harris *et al*, 2004). One study found the contents of the bottle, such as sugar-sweetened milk or juice, were significantly more important than the age of weaning for caries risk (Reisine and Psoter, 2001). Dentists and dental auxiliaries should provide information to caregivers about drinking only unsweetened milk or drinking fruit juice from a cup.

There were limitations to the present study. Our study was conducted among subjects from a low socioeconomic status in rural areas; therefore, the generalizability of these results is limited. The examination performed in this study was done using natural light only and could have missed tooth problems.

In conclusion, the prevalence of ECC in this study among Thai children aged 9-18 months was high. Caries started at a young age during the first year of life. Nighttime bottle feeding, frequency of drinking sweetened milk, and falling asleep with a bottle in the mouth were associated with caries risk.

ACKNOWLEDGEMENTS

This study was supported by the Dental Research Fund, Faculty of Dentistry, Chulalongkorn University. We express our sincere thanks to Dr Pimolphan Laungwechakan, head of the Dental Department, U thong Hospital for coordinating the study area and Miss Sututta Srihara for the examination team and the primary caregivers. We also thank Dr Kevin Tompkins, Chulalongkorn University, for revising the manuscript.

REFERENCES

Adair PM, Pine CM, Burnside G, *et al.* Familial and cultural perceptions and beliefs of oral hygiene and dietary practices among ethnically and socio-economicall diverse groups. *Community Dent Health* 2004; 21 (suppl 1): 102-11.

American Academy of Pediatric Dentistry. Guidline on fluoride therapy. *Pediatr Dent* 2012; 36: 162-5.

Brice DM, Blum JR, Steinberg BJ. The etiology, treatment, and prevention of nursing caries. *Compend Contin Educ Dent* 1996; 17: 92, 4, 6-8 passim.

De Grauwe A, Aps JK, Martens LC. Early Childhood Caries (ECC): what's in a name? *Eur J Paediatr Dent* 2004; 5: 62-70.

Dennison BA. Fruit juice consumption by infants and children: a review. *J Am Coll Nutr* 1996; 15 (suppl 5): S4-11.

Dental Health Division. The 6th National Oral Health Survey 2006-2007, Bangkok, Thailand. Nonthaburi: Department of Health, Ministry of Public Health, 2008.

Dental Health Division. The 7th National Oral Health Survey 2012, Bangkok, Thailand. Nonthaburi: Department of Health, Ministry of Public Health, 2012a.

Dental Health Division. Comparison of the 2-7th National Oral Health Survey 1987-2012, Bangkok, Thailand. Department of Health, Ministry of Public Health, 2012b. [Cited 2014 Oct 10]. Available from: http://www.anamai.ecgates.com/userfiles/file/compare.pdf

Featherstone JDB, Nelson DGA, McLean JD. An electron microscope study of modifications to defect regions in dental enamel and synthetic apatites. *Caries Res* 1981; 15: 278-88.

Greene JC, Vermillion JR. The Simplified Oral Hygiene Index. *J Am Dent Assoc* 1964; 68: 7-13.

Harris R, Nicoll AD, Adair PM, Pine CM. Risk factors for dental caries in young children: a systematic review of the literature. *Community Dent Health* 2004; 21 (suppl 1): 71-85.

Jose B, King NM. Early childhood caries lesions in preschool children in Kerala, India. *Pediatr Dent* 2003; 25: 594-600.

Loe H. The Gingival Index, the Plaque Index and the Retention Index Systems. *J Periodontol* 1967; 38: (suppl): 610-6.

Marino RV, Bomze K, Scholl TO, Anhalt H. Nursing bottle caries: characteristics of children at risk. *Clin Pediatr (Phila)* 1989; 28: 129-31.

Milgrom P. Response to Reisine & Douglass: psychosocial and behavioral issues in early childhood caries. *Community Dent Oral Epidemiol* 1998; 26 (suppl 1): 45-8.

National Statistical Office Moiact. Income expenditure and debt in 2011. Bangkok: National Statistic Office, 2011. [Cited 2012 Oct 20]. Available from: http://web.nso.go.th/

Reisine ST, Psoter W. Socioeconomic status and selected behavioral determinants as risk factors for dental caries. *J Dent Educ* 2001; 65: 1009-16.

Seow WK. Biological mechanisms of early childhood caries. *Community Dent Oral Epidemiol* 1998; 26 (suppl 1): 8-27.

Subsandee K, Chongvisal S, Kittitavornkul N, Wangprasertkul N. Bottle-using behaviors in a group of Bangkok preschool children. *CU Dent J* 2008; (31): 273-82.

Suphan Buri Provincial Public Health Office. Dental status 2012. Suphan Buri: Suphan Buri Provincial Public Health Office, 2012a. [Cited 2013 Feb 15]. Available from: http://spo.go.th/web/ddent/index.php/home-2

Suphan Buri Provincial Public Health Office. Report on analysis of fluoride in water, Suphan Buri Province (2012). Suphan Buri: Suphan Buri Provincial Public Health Office, 2012b. [Cited 2012 Feb 15]. Available from: http://spo.go.th/web/ddent/index.php/home-2

Sutthavong S, Taebanpakul S, Kuruchitkosol C, *et al.* Oral health status, dental caries risk factors of the children of public kindergarten and schools in Phranakornsriayudhya, Thailand. *J Med Assoc Thai* 2010; 93 (suppl 6): S71-8.

Tabachnick BG, Fidell LS. Using multivariate statistics. 5th ed. Boston: Pearson Education, 2007.

Thailand Information Center (TIC). U-thong sub-district population. Bangkok: Thai-

land Information Center, 2012. [Cited 2012 Feb 15]. Available from: http://suphanburi.kapook.com/

Thanakanjanaphakdee W, Triratvorakul C. Effectiveness of parental hand-on toothbrushing instruction toward the 1-year incremental dmf rate of 9-18 month old children. *J Dent Assoc Thai* 2010; 60: 85-94.

Thitasomakul S, Piwat S, Thearmontree A, Chankanka O, Pithpornchaiyakul W, Madyusoh S. Risks for early childhood caries analyzed by negative binomial models. *J Dent Res* 2009; 88: 137-41.

Thitasomakul S, Thearmontree A, Piwat S, *et al.* A longitudinal study of early childhood caries in 9- to 18-month-old Thai infants. *Community Dent Oral Epidemiol* 2006; 34: 429-36.

Touger-Decker R, van Loveren C. Sugars and dental caries. *Am J Clin Nutr* 2003; 78: 881S-92S.

Vachirarojpisan T, Shinada K, Kawaguchi Y, Laungwechakan P, Somkote T, Detsomboonrat P. Early childhood caries in children aged 6-19 months. *Community Dent Oral Epidemiol* 2004; 32: 133-42.

Vanobbergen J, Martens L, Lesaffre E, Bogaerts K, Declerck D. Assessing risk indicators for dental caries in the primary dentition. *Community Dent Oral Epidemiol* 2001; 29: 424-34.

Veerkamp JS, Weerheijm KL. Nursing-bottle caries: the importance of a development perspective. *ASDC J Dent Child* 1995; 62: 381-6.

Warren JJ, Kramer KW, Phipps K, *et al.* Dental caries in a cohort of very young American Indian children. *J Public Health Dent* 2012; 72: 265-8.

Warren JJ, Levy SM, Kanellis MJ. Dental caries in the primary dentition: assessing prevalence of cavitated and noncavitated lesions. *J Public Health Dent* 2002; 62: 109-14.

Wigen TI, Wang NJ. Parental influences on dental caries development in preschool children. An overview with emphasis on recent Norwegian research. *Norsk Epidemiol* 2012; 22: 13-9.

Williams SA, Hargreaves JA. An inquiry into the effects of health related behaviour on dental health among young Asian children resident in a fluoridated city in Canada. *Community Dent Health* 1990; 7: 413-20.

Wong MC, Clarkson J, Glenny AM, *et al.* Cochrane reviews on the benefits/risks of fluoride toothpastes. *J Dent Res* 2011; 90: 573-9.

Wong MC, Glenny AM, Tsang BW, Lo EC, Worthington HV, Marinho VC. Topical fluoride as a cause of dental fluorosis in children. *Cochrane Database Syst Rev* 2010; CD007693.