

Early Childhood Caries and Risk Factors in Vietnam

Yen Hoang Thi Nguyen*/ Masayuki Ueno**/ Takashi Zaitso***/ Toai Nguyen****/
Yoko Kawaguchi*****

Objective: To investigate caries prevalence and examine its relationship with socioeconomic status and oral health behavior of Vietnamese kindergarten children. **Study design:** The study was carried out on 1,028 children aged 2-5 years in six kindergartens in Thua Thien Hue province, Vietnam. Information about socioeconomic and oral health behaviors was collected through a self-administered questionnaire, and oral health status by clinical dental examination. **Results:** Clinical dental examination found that overall caries prevalence and mean dmft were 89.1% and 9.32. Caries prevalence and mean dmft increased greatly from two years to three years old, and gradually developed from three years to five years old. A logistic regression revealed that caries had an inverse relationship with mothers' educational level and a positive relationship with the habit of retaining food in the mouth for a long time in two-year-old children. Prolonged breastfeeding, more frequent sweets consumption, no thumb sucking habit, and higher modified debris index score were the risk factors for caries among three-to-five-year-old children. **Conclusions:** This study indicated a high prevalence of caries and related risk factors such as low mother's educational level and inappropriate oral health behavior among kindergarten children in Vietnam.

Key words: early childhood caries, risk factors, preschool children, Vietnam

INTRODUCTION

Early childhood caries (ECC) is defined as the presence of one or more decayed (non-cavitated or cavitated) lesions, missing (due to caries), or filled tooth surfaces in any primary tooth in a child under 72 months, according to the latest definition by the American Academy of Pediatric Dentistry (2014)¹ ECC has also been called "nursing caries" or "bottle caries"².

ECC is a significant oral health problem among young children worldwide, especially in developing countries, due to an enormous number of untreated decayed teeth³. Caries is a multifactorial disease which is arguably the most common disease to affect children⁴. As many studies have reported, ECC not only has adverse effects on health and quality of life in children but also creates a huge financial burden for families. Pain and infection are direct consequences of ECC, which reduces eating ability and sleep quality. Such conditions may even inhibit neural development and somatic growth^{5,6}. ECC also interferes with pronunciation and communication, which may lead to children losing confidence⁷. Children who have caries in their early life are more likely to have caries in adulthood⁸. The cost of treating ECC is high, especially when general anesthesia is administered to uncooperative children. As repetitive dental visits are necessary, time spent on treatment may put a strain on both parents and children.

The last national oral health survey in Vietnam was conducted in 1999 and the data were collected from children aged six years and older⁹. Therefore, no national data

*Yen Hoang Thi Nguyen, DDS, Department of Oral Health Promotion, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan. Faculty of Odonto-Stomatology, Hue University of Medicine and Pharmacy, Hue University, Hue, Vietnam.

** Masayuki Ueno, DDS, PhD, MPH, Associate Professor, Department of Oral Health Promotion, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan.

*** Takashi Zaitso, DDS, PhD, Assistant Professor, Department of Oral Health Promotion, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan.

****Toai Nguyen, DDS, PhD, Associate Professor, Faculty of Odonto-Stomatology, Hue University of Medicine and Pharmacy, Hue University, Hue, Vietnam.

***** Yoko Kawaguchi, DDS, PhD, Professor, Department of Oral Health Promotion, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan.

Send all correspondence to:

Masayuki Ueno

Department of Oral Health Promotion

Graduate School of Medical and Dental Sciences

Tokyo Medical and Dental University

1-5-45 Yushima, Bunkyo-ku, Tokyo, Japan

Phone: +81 3 5803 5478

E-mail: ueno.ohp@tmd.ac.jp

on caries in preschool children are available. Lack of data on caries in children leads to a failure to comprehend fully the current situation and a failure to implement measures for promoting child oral health. Moreover, without information the general public cannot learn about ECC and its prevention.

Therefore, the aims of this study were to investigate caries prevalence in Vietnamese kindergarten children and to examine its relationship with socioeconomic status and oral health behaviors.

MATERIALS AND METHOD

Six public kindergartens in Thua Thien Hue province, Vietnam were selected as a convenience sample for the study. Initially, 1,112 caregivers of kindergarten children signed a consent form and answered a questionnaire, distributed by the kindergarten teachers from March to April 2015. After excluding 84 children, whose questionnaires had missing information, a total of 1,028 children, 572 boys (55.6%) and 456 girls (44.4%), aged two to five years were included in this study.

Questionnaire survey

A self-administered questionnaire survey was conducted to collect information about socioeconomics and oral health behaviors. The questionnaire items assessed the educational level of mothers (up to middle school or high school and above), child's eating behavior including weaning age (≤ 12 months, 13-18 months, > 18 months, or never breast-fed) and duration of bottle-feeding (≤ 12 months, 13-18 months, > 18 months, or not bottle-fed), habit of retaining food in the mouth for a long period of time (yes or no), frequency of sweet food and drink consumption at home (< 2 times or ≥ 2 times daily), water drinking after breast- or bottle-feeding (usually or rarely), rinsing mouth with water after eating (usually or rarely), thumb sucking (yes or no), and a question about who brushed the child's teeth (both child and parent, parent only, child only, or not started yet).

Clinical oral examination

Two calibrated dentists conducted clinical oral examination. First, the oral hygiene of children was assessed using the modified debris index (DI) of Greene and Vermillion¹⁰. The presence of plaque by modified DI was visually evaluated on the buccal surfaces of six index teeth: upper right second molar (55), upper right central incisor (51), upper left second molar (65), lower left second molar (75), lower left central incisor (71) and lower right second molar (85). The amount of plaque was recorded based on a four-level score: 0—no plaque present, 1—plaque covering not more than one-third of tooth surface, 2—plaque covering more than one-third but not more than two-thirds of tooth surface, 3—plaque covering more than two-thirds of tooth surface. The score of each tooth surface was added and divided by the number of recorded tooth surfaces. The modified DI score was then dichotomized (≤ 1 and >1) for the purpose of statistical analysis. The inter-examiner Kappa scores were 0.70 to 0.75 for modified DI evaluation.

Following the oral hygiene assessment, the teeth were cleaned by examiners using a tooth brush without tooth-paste prior to dental examination. The examination was then conducted by two calibrated dentists according to the WHO standard criteria (2013)¹¹ with a dental mirror, a WHO periodontal probe and a flash light. Radiographs were not used in this study. Missing teeth due to exfoliation or trauma were excluded from the calculation of dmft scores. The inter-examiner Kappa scores were 0.77 to 0.89 for caries assessment.

Data analysis

The subjects were divided into two groups by age (two-year-olds and three-to-five-year-olds) to compare socioeconomic factors, oral health behaviors, oral hygiene status and to examine their association with caries status. Data were analyzed using SPSS software (19.0, IBM Corp, Armonk, NY, USA). Chi-square test was used to determine the distributional difference in caries prevalence between categorical variables. Differences in mean dmft were analyzed with ANOVA followed by Tukey multiple comparisons. A logistic regression model was used to identify predictors for caries prevalence (0: no caries, 1: caries) with all potential risk factors for caries as independent variables (sex, mother's educational level, duration of breast-feeding, duration of bottle-feeding, retention of food in the mouth for a long period of time, sweet food consumption, sweet drink consumption, water drinking after breast- or bottle-feeding, mouth rinsing after eating, sucking habits, persons who brush child's teeth, and modified DI score). Statistical significance was set at $p < 0.05$ for all tests.

Ethical approval

This study protocol was approved by the Ethics Committees of Hue University of Medicine and Pharmacy, Vietnam and Tokyo Medical and Dental University, Japan (Approval number: 1,173).

RESULTS

Oral health status

The mean number of teeth, caries prevalence and dmft of all children were 19.7, 89.1% and 9.32, respectively. The dominant component of dmft was decayed teeth (dt: 9.21, mt: 0.04, and ft: 0.11). Fewer than 5% of children had filled teeth, and 0.9% had missing teeth.

As Table 1 shows, the caries prevalence and mean dmft by age were: 72.4% and 5.57 in two-year-olds; 90.7% and 9.68 in three-year-olds; 93.0% and 10.42 in four-year-olds; and 94.5% and 10.36 in five-year-olds, respectively. A great increase of caries prevalence was found from two years to three years old, and caries gradually developed after three years old. Similarly, the mean dmft rose quickly between two and three years old, and a slight increase of dmft continued from three to five years of age. There was no statistically significant difference in caries prevalence or mean dmft by sex at any age.

Figure 1. Distribution of caries by tooth and age

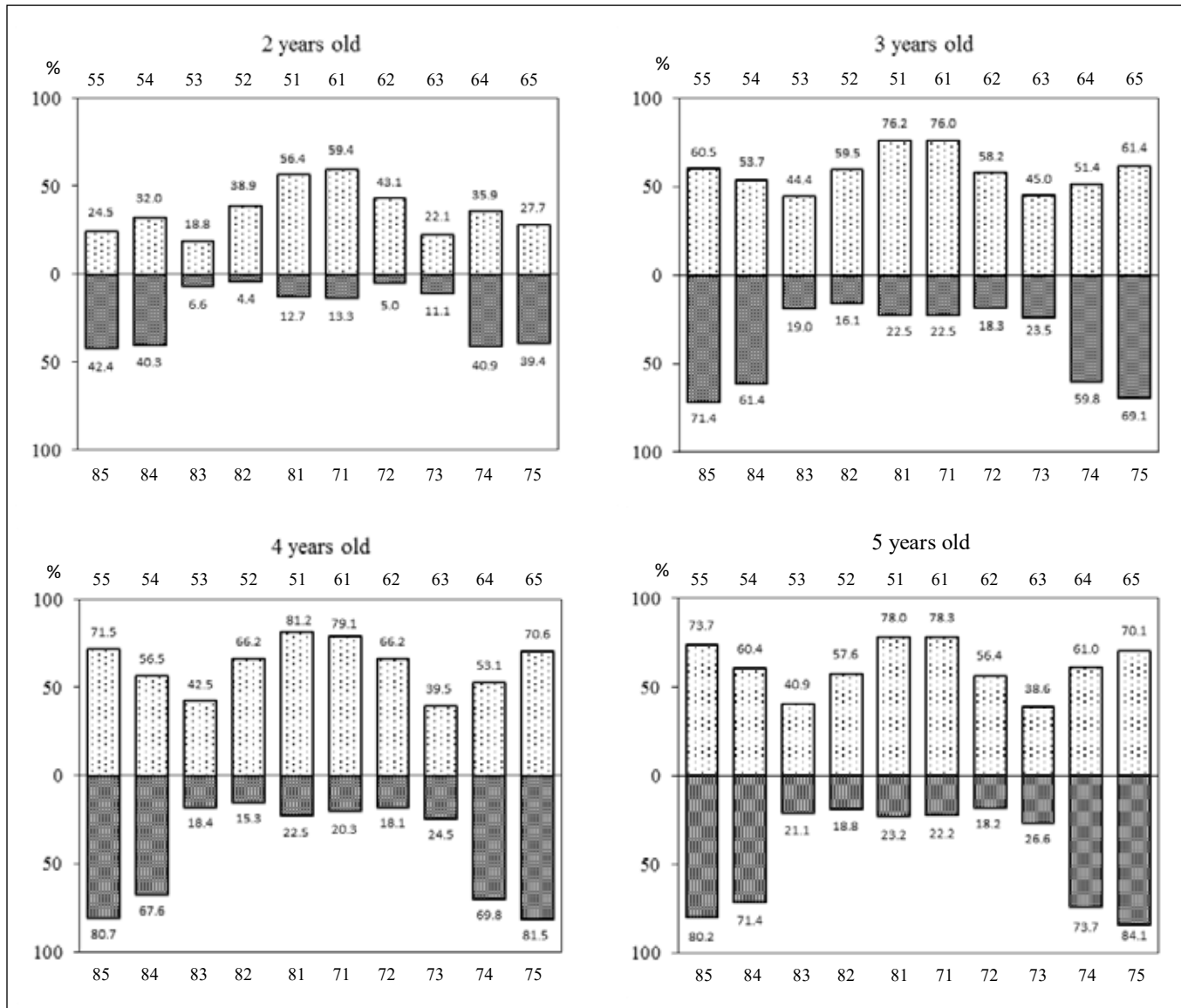


Table 1: Caries prevalence and mean dmft by age and sex

Age (years)	Number of children			Caries prevalence (%)			p-value	dmft±SD			p-value
	Total	Boy	Girl	Total	Boy	Girl		Total	Boy	Girl	
2	181	109	72	72.4	76.1	66.7	0.163	5.57±4.76	5.94±4.72	5.01±4.80	0.203
3	311	165	146	90.7	89.1	92.5	0.307	9.68±5.51	9.53±5.44	9.86±5.59	0.600
4	228	135	93	93.0	92.6	93.5	0.781	10.42±5.18	10.27±5.26	10.63±5.08	0.599
5	308	163	145	94.5	92.6	96.6	0.133	10.36±5.33	9.96±5.20	10.81±5.46	0.166
Total	1,028	572	456	89.1	88.5	89.9	0.458	9.32±5.54	9.14±5.42	9.55±5.68	0.237

The distribution of caries prevalence by individual tooth and age is illustrated in Figure 1. No significant difference in caries prevalence was observed between the right and the left sides ($p = 0.663$). At any age, maxillary central incisors were most affected, followed by first or second molars, and canines had the lowest caries prevalence of all teeth.

In the maxilla, about 60% of central incisors were

affected in two-year-olds and this increased to 76% in three-year-olds. Caries prevalence of second molars rose from 26% to 61% between two and three-year-olds. In the mandible, first and second molars were most affected in two-year-olds. Caries prevalence in mandibular second molars exceeded that in first molars after three years of age ($p < 0.001$).

Socioeconomic status and oral health behavior

Table 2 shows socioeconomic status and oral health behavior by two age groups. Over 55% of mothers had high school education or above. Most of the children (97.3%) had been breast-fed and about three-quarters of them (73.1%) were breast-fed beyond one year of age. One year or longer bottle-feeding was reported for 64% of children and about 30% had not been bottle-fed. Approximately 40% of children had a habit of retaining food in the mouth for a long period of time. Around two-thirds of them consumed sweet food (59.3%) or drinks (63.1%) at least twice a day at home. Children

who usually drank water after breast- or bottle-feeding and rinsed their mouth after eating made up 62.9% and 48.8%, respectively. More than a quarter of the children (26.5%) had a habit of thumb sucking. The only significant difference by age group was regarding the person who brushed the child's teeth ($p < 0.001$). More than half (54.7%) of tooth brushing in two-year-olds was done by a parent alone and 21% had not started brushing yet. Among three-to-five-year-olds, about 40% brushed their own teeth, 33% were brushed by parents, and 4% had not started brushing yet. Most children's (93%) modified DI score was greater than 1.0.

Table 2. Socioeconomic status and oral health behaviours by age groups

Variable	Total		2 years old		3-5 years old		p-value
	N	%	N	%	N	%	
Mother's educational level							
Up to middle school	448	43.6	71	39.2	377	44.5	0.193
High school and above	580	56.4	110	60.8	470	55.5	
Duration of breast-feeding							
≤12 months	231	22.5	49	27.1	182	21.5	0.171
13-18 months	344	33.5	64	35.4	280	33.1	
>18 months	407	39.6	63	34.8	344	40.6	
No breast-feeding	46	4.5	3	2.8	41	4.8	
Duration of bottle-feeding							
≤ 12 months	55	5.4	11	6.1	44	5.2	0.317
13-18 months	69	6.7	17	9.4	52	6.1	
>18 months	588	57.2	104	57.5	484	57.1	
No bottle-feeding	316	30.7	49	27.1	267	31.5	
Retains food in mouth for a long time							
Yes	420	40.9	70	38.7	350	41.3	0.511
No	608	59.1	110	61.3	497	58.7	
Sweet food consumption at home							
< 2times daily	418	40.7	79	43.6	339	40.0	0.368
≥2 times daily	610	59.3	102	56.4	508	60.0	
Sweet drink consumption at home							
< 2times daily	379	36.9	76	42.0	303	35.8	0.116
≥2 times daily	649	63.1	105	58.0	544	64.2	
Water drinking after breast or bottle-feeding							
Usually	647	62.9	116	64.1	531	62.7	0.724
Rarely	381	37.1	65	35.9	316	37.3	
Mouth rinsing after eating							
Usually	502	48.8	91	50.3	411	48.5	0.699
Rarely	526	51.2	90	49.7	436	51.5	
Thumb sucking							
No	757	73.6	125	69.1	632	74.6	0.124
Yes	271	26.4	56	30.9	215	25.4	
Persons who brush child's teeth							
Both child and parent	213	20.7	27	14.9	186	22.0	<0.001
Parent only	379	36.9	99	54.7	280	33.0	
Child only	366	35.6	17	9.4	349	41.2	
Not yet	70	6.8	38	21.0	32	3.8	
Modified DI score							
≤ 1	72	7.0	16	8.8	56	6.6	0.286
> 1	956	93.0	165	91.2	791	93.4	

Relationship of caries status with socioeconomic status and health behavioral variables.

Table 3 presents the association between caries status and study variables. In two-year-olds, those whose mother had a higher educational level showed significantly lower caries prevalence ($p < 0.01$) and dmft ($p < 0.05$). Longer breast-feeding had a significant relationship with higher caries prevalence ($p < 0.05$). Significantly higher caries prevalence ($p < 0.05$) and dmft ($p < 0.001$) were associated with a food retention habit.

In the three-to-five-year-old group, those whose mother had a higher educational level had significantly lower dmft scores ($p < 0.001$). Longer duration of breast-feeding was significantly associated with higher caries prevalence ($p < 0.01$) and dmft ($p < 0.05$). Children with a food retention habit had significantly higher caries experience (dmft; $p < 0.05$). Caries prevalence ($p < 0.05$) and dmft ($p < 0.001$) were significantly higher among children who consumed sweet food or drinks at least twice a day. Children who had habits of drinking water after breast- or bottle-feeding and mouth rinsing after eating showed significantly lower caries prevalence ($p < 0.05$) and dmft ($p < 0.05$). A significantly lower caries prevalence was observed among children who sucked their thumbs ($p < 0.01$). Children whose teeth were brushed both by themselves and a parent had significantly lower dmft scores than those who had not started brushing yet ($p < 0.05$). Higher modified DI was significantly associated with higher caries prevalence ($p < 0.001$) and dmft ($p < 0.001$).

Logistic regression on caries prevalence

The results of the logistic regression analysis on caries prevalence are displayed in Table 4. In two-year-olds, those whose mothers had lower educational level showed a 2.43 times higher risk of having caries experience ($p < 0.05$). In addition, retaining food in the mouth for long was a significant risk factor for caries (OR=2.50, $p < 0.05$).

Among children aged three to five years, longer breast-feeding had a significant positive association with caries prevalence (OR=3.11 for 13-18 months and OR= 3.25 for more than 18 months). Sweet food consumption and caries prevalence were significantly associated; more frequent consumption was associated with higher caries prevalence (OR=2.21, $p=0.01$). Thumb sucking was negatively associated with caries prevalence (OR=0.40, $p < 0.01$). Having a higher modified DI score was a strong predictor of caries; children with a score more than 1.0 showed a significantly higher caries experience (OR= 8.69, and $p < 0.001$).

DISCUSSION

This study revealed a serious oral health problem among kindergarten children in Thua Thien Hue province, Vietnam. The results showed an early onset of caries as more than 70% of two-year-olds had caries. Caries progressed very quickly and three-year-olds had about 10 decayed teeth. Most caries was untreated and just 5% of children had received treatment. The findings imply children's oral health receives little attention. One of the reasons for this may be the fact that many

Vietnamese people believe primary teeth are not important because they are replaced by permanent teeth. However, caries interferes considerably with children's daily life⁵⁻⁷.

There is a national health insurance system in Vietnam but it is not compulsory. The insurance fully covers treatment fees for children under six years old, but it does not cover treatment performed in private clinics¹². Most children do not go to a dentist regularly and parents usually bring their child to a dentist only if there is pain.

In this study, lower educational level of mothers was associated with higher caries in two-year-olds and was considered to be an important social determinant of children's oral health. Former studies similarly indicated that the prevalence of caries was higher among children whose mothers were less-well-educated^{13,14,15}. Mothers with low level of education may think oral health is not important, as other studies have reported^{16,17}. Such mothers may lack correct knowledge of oral disease and information about appropriate oral health care.

Breast milk is a rich and irreplaceable source of nutrition for children but prolonged breast-feeding increases the risk for caries¹⁸. According to Vietnamese guideline for breast-feeding, children should be breast-fed up to two years of age¹⁹. In this study, three-to-five-year-old children who had been breast-fed for more than 12 months had higher risk for caries. Although long-time breast-feeding is recommended for Vietnamese women¹⁹, they should be aware that breast-feeding increases the risk of caries if mothers do not take good care of their child's oral hygiene.

Consumption of sweet snacks has been recognized as a key behavioral factor for caries occurrence in children²⁰. Many studies have reported a positive relationship between frequent intake of sweets and caries prevalence^{21,22}. In Vietnam, public kindergarten children are usually given sweet snacks such as pudding or yogurt at least once a day. Most formula milk, which children drink daily at kindergartens, also contains sugar. Further, not only do children have easy access to sweets but mothers also tend to give their child sweets to stop crying. In this study, three-to-five-year-olds who snacked twice daily or more at home had a higher risk of caries. High caries experience was found even in children who ate sweets less than twice a day. Hence, intake of sweets should be controlled both at home and in kindergartens.

Sucking habits in infants and young children are thought to arise from the physiological need for nutrients. Thumb sucking is also a way of satisfying psychological desires of children²³. Previous studies have reported that 23% of Nigerian pre-schoolers, and 14% of American three-year-olds had thumb sucking habits^{23,24}. In this study, about 26% of children had a habit of thumb sucking. According to a Japanese study, three-year-olds with a thumb sucking habit were more likely to be free of caries²⁵. Our findings also found that children aged three to five years who had this habit had significantly lower caries experience. It is considered that thumb sucking may increase saliva flow and neutralise acids in the mouth^{26,27}. Although thumb sucking may reduce caries, as this study suggests, it entails a risk of malocclusion.

Table 3. Relationship of caries status with socioeconomic and health behavioural variables

Variable	2 years old					3-5 years old				
	Caries					Caries				
	N	prevalence (%)	p-value	dmft	p-value	N	prevalence (%)	p-value	dmft	p-value
Sex										
Boy	109	76.1	0.163	5.94	0.203	463	91.4	0.105	9.90	0.170
Girl	72	66.7		5.01		384	94.3		10.40	
Mother's educational level										
High school and above	110	64.5	0.003	4.98	0.039	470	91.3	0.080	9.60	<0.001
Up to middle school	71	84.5		6.48		377	94.4		10.79	
Duration of breast-feeding										
≤12 months	49	55.1	0.012	4.35	0.109	182	87.4	0.007	9.29	0.036
13-18 months	64	79.7		5.53		280	94.6		10.03	
>18 months	63	79.4		6.57		344	94.5		10.69	
No breast-feeding	5	60.0		5.4		41	87.8		9.78	
Duration of bottle-feeding										
≤ 12 months	11	72.7	0.160	4.82	0.517	44	90.9	0.886	10.45	0.856
13-18 months	17	76.5		5.35		52	92.3		9.60	
>18 months	104	66.3		5.28		484	92.4		10.19	
No bottle-feeding	49	83.7		6.43		267	93.6		10.06	
Retains food in mouth for a long time										
No	111	66.7	0.031	4.70	0.002	497	92.0	0.332	9.76	0.019
Yes	70	81.4		6.94		350	93.7		10.64	
Sweet food consumption at home										
< 2times daily	79	69.6	0.466	4.96	0.132	339	88.2	<0.001	8.65	<0.001
≥2 times daily	102	74.5		6.04		508	95.7		11.11	
Sweet drink consumption at home										
< 2times daily	76	76.3	0.313	5.30	0.523	303	89.8	0.015	9.03	<0.001
≥2 times daily	105	69.5		5.76		544	95.7		10.74	
Water drinking after breast or bottle feeding										
Usually	116	72.4	0.988	5.41	0.559	531	91.0	0.013	9.64	<0.001
Rarely	65	72.3		5.85		316	95.6		10.94	
Mouth rinsing after eating										
Usually	91	72.5	0.963	5.35	0.538	411	90.0	0.004	9.66	0.014
Rarely	90	72.2		5.79		436	95.2		10.56	
Thumb sucking										
No	125	75.2	0.204	5.63	0.791	632	94.1	0.005	10.26	0.221
Yes	56	66.1		5.43		215	88.4		9.74	
Persons who brush child's teeth										
Both child and parent	27	77.8	0.356	6.15	0.604	186	92.5	0.808	9.46	0.029
Parent only	99	68.7		5.18		280	92.1		10.49	
Child only	17	88.2		6.59		349	92.8		10.00	
Not yet	38	71.1		5.71		32	96.9		12.16	
Modified DI score										
≤ 1	16	43.8	0.007	2.00	0.002	56	62.5	<0.001	4.39	<0.001
> 1	165	75.2		5.92		791	94.8		10.53	

Downloaded from http://meridian.allenpress.com/jcpd/article-pdf/42/3/173/1750547/1053-4628-42_3_2.pdf by guest on 22 April 2024

Table 4. Logistic regression models on caries status by age groups

Independent variable	2 years old				3-5 years old			
	95% CI				95% CI			
	OR	Lower	Upper	p-value	OR	Lower	Upper	p-value
Sex								
Boy	ref				ref			
Girl	0.55	0.25	1.21	0.137	1.63	0.90	2.96	0.108
Mother's educational level								
High school or above	ref				ref			
Up to middle school	2.43	1.02	5.78	0.045	1.44	0.77	2.71	0.255
Duration of breast-feeding								
≤12 months	ref				ref			
13-18 months	2.54	0.98	6.57	0.055	3.11	1.42	6.82	0.005
>18 months	2.08	0.77	5.58	0.147	3.25	1.53	6.90	0.002
No breast-feeding	1.70	0.15	19.39	0.670	1.02	0.31	3.38	0.981
Duration of bottle-feeding								
≤ 12 months	ref				ref			
13-18 months	1.10	0.15	8.10	0.929	1.08	0.21	5.50	0.929
>18 months	0.72	0.15	3.41	0.674	1.04	0.30	3.56	0.954
No bottle-feeding	1.07	0.27	10.50	0.570	0.79	0.21	2.92	0.723
Retains food in mouth for a long time								
No	ref				ref			
Yes	2.50	1.10	5.71	0.029	1.37	0.72	2.61	0.331
Sweet food consumption at home								
<2 times daily	ref				ref			
≥ 2 times daily	0.99	0.43	2.30	0.993	2.22	1.21	4.10	0.010
Sweet drink consumption at home								
< 2 times daily	ref				ref			
≥ 2 times daily	0.84	0.38	1.84	0.659	1.64	0.89	3.00	0.112
Water drinking after breast or bottle-feeding								
Usually	ref				ref			
Rarely	1.01	0.43	2.36	0.981	1.50	0.75	3.02	0.256
Mouth rinsing after eating								
Usually	ref				ref			
Rarely	0.89	0.39	2.03	0.776	1.82	0.95	3.48	0.072
Thumb sucking								
No	ref				ref			
Yes	0.53	0.23	1.24	0.143	0.40	0.21	0.76	0.005
Person who brush child's teeth								
Both child and parent	ref				ref			
Parent only	0.68	0.20	2.25	0.524	1.10	0.50	2.38	0.818
Child only	2.03	0.28	14.73	0.483	1.04	0.49	2.24	0.915
Not yet	0.87	0.22	3.43	0.847	2.03	0.24	17.12	0.516
Modified DI score								
≤ 1	ref				ref			
> 1	2.73	0.73	10.13	0.134	8.85	4.38	17.86	<0.001

Two-year-olds who retained food in the mouth for a long time had a higher caries risk in this study. Prolonged oral food retention may prolong carbohydrate fermentation and increase the risk of caries². Caregivers should pay attention to this habit by telling children not to keep food in their mouth so long.

Proper oral hygiene and use of fluoride toothpaste are important for the prevention of caries in children^{28,29}. In Vietnam, since most children's toothpastes contain fluoride, caries prevention effects are to be expected if appropriately used. Previous studies indicated that pre-schoolers who had a high plaque score showed more caries^{30,31}. In this study, a lower modified DI score was closely associated with lower caries prevalence among three-to-five-year-olds. Practising tooth brushing is surely important but quality of oral hygiene by tooth brushing is a decisive factor in caries prevention³⁰. Therefore, parents at home and teachers at kindergartens are key persons who can assist children to clean their teeth properly.

Caregivers, the majority of them mothers, need to be well educated about oral health and hygiene, and the health education should include the importance of deciduous teeth, causes of dental caries, diet, tooth brushing, fluoride toothpaste, and regular dental check-ups. Besides mothers, teachers play an important role in taking care of children's oral health in kindergartens and should be educated.

Since caries was found at a very young age, preventive measures against caries should be undertaken before two years of age. Dental examination for children is recommended at least once a year in kindergartens to detect early caries. When dental problems which need attention are found, appropriate care should be provided to children in cooperation with local dentists. Applying silver diamine fluoride may be an effective method to prevent and arrest caries^{32,33}.

As there are differences in socioeconomic distribution, healthcare accessibility, and culture between different regions in Vietnam, it is not possible to generalise fully the present findings to all Vietnamese children. However, these findings could be used as a resource for people who have responsibility for children, policy makers, caregivers, kindergarten teachers, and oral health professionals to understand the actual oral health condition and risk factors in Vietnamese children. To improve children's oral health status, increasing community awareness of ECC as a serious public health problem through media such as television, newspapers, and leaflets, and planning a new policy aimed at remedying this condition require urgent action.

There is a limitation in the study. Since a convenience sample was used, the results in this study could not be generalized to all children in the country. Therefore, a national oral health survey should be conducted in the future to grasp an accurate picture view of Vietnamese children's oral health condition.

CONCLUSIONS

This study revealed a high prevalence of ECC and its risk factors among kindergarten children in Thua Thien Hue province, Vietnam. Increasing people's knowledge of ECC, planning new strategies, and implementing effective interventions are the important strategies to improve the oral health status of Vietnamese children.

ACKNOWLEDGEMENTS

We would like to express our sincere gratitude to the parents and children who participated in this study. We also would like to thank the health authorities, dentists, students, and kindergarten teachers who supported this project with help and encouragement during data collection. A part of this study was financially supported by the Futokukai Foundation.

REFERENCES

1. Policy on early childhood caries (ECC): classifications, consequences, and preventive strategies. *Pediatr Dent* 37: 30-32, 2014.
2. Misra S, Tahmassebi JF, Brosnan M. Early childhood caries-a review. *Dent Update* 34: 556-558, 561-552, 564, 2007.
3. Schwendicke F, Dorfer CE, Schlattmann P, Foster Page L, Thomson WM, Paris S. Socioeconomic inequality and caries: a systematic review and meta-analysis. *J Dent Res* 94: 10-18, 2015.
4. Wong HM, McGrath CP, King NM, Lo EC. Oral health-related quality of life in Hong Kong preschool children. *Caries Res* 45: 370-376, 2011.
5. Acs G, Shulman R, Ng MW, Chussid S. The effect of dental rehabilitation on the body weight of children with early childhood caries. *Pediatr Dent* 21: 109-113, 1999.
6. Li MY, Zhi QH, Zhou Y, Qiu RM, Lin HC. Impact of early childhood caries on oral health-related quality of life of preschool children. *Eur J Paediatr Dent* 16: 65-72, 2015.
7. Leong PM, Gussy MG, Barrow SY, de Silva-Sanigorski A, Waters E. A systematic review of risk factors during first year of life for early childhood caries. *Int J Paediatr Dent* 23: 235-250, 2013.
8. Thomson WM, Poulton R, Milne BJ, Caspi A, Broughton JR, Ayers KM. Socioeconomic inequalities in oral health in childhood and adulthood in a birth cohort. *Community Dent Oral Epidemiol* 32: 345-353, 2004.
9. Loc Giang D, Spencer AJ, Roberts-Thomson KF, Hai Dinh T, Thuy Thanh N. Oral health status of Vietnamese children: findings from the National Oral Health Survey of Vietnam 1999. *Asia Pac J Public Health* 23: 217-227, 2011.
10. Greene JC, Vermillion JR. The simplified oral hygiene index. *J Am Dent Assoc* 68: 7-13, 1964.
11. World Health Organization. Oral health surveys: basic methods, 5th edn. Geneva: WHO, 2013.
12. Law of health insurance. http://vanban.chinhphu.vn/portal/page/portal/chinhphu/hethongvanban?class_id=1&_page=1&mode=detail&document_id=81142. (in Vietnamese) Accessed December 27, 2016.
13. Kiwanuka SN, Astrom AN, Trovik TA. Dental caries experience and its relationship to social and behavioural factors among 3-5-year-old children in Uganda. *Int J Paediatr Dent* 14: 336-346, 2004.
14. Sankeshwari RM, Ankola AV, Tangade PS, Hebbal MI. Association of socio-economic status and dietary habits with early childhood caries among 3-to-5-year-old children of Belgaum city. *Eur Arch Paediatr Dent* 14: 147-153, 2013.
15. Ramos-Gomez FJ, Weintraub JA, Gansky SA, Hoover CI, Featherstone JD. Bacterial, behavioral and environmental factors associated with early childhood caries. *J Clin Pediatr Dent* 26: 165-173, 2002.
16. Åström AN, Kiwanuka SN. Examining intention to control preschool children's sugar snacking: a study of carers in Uganda. *Int J Paediatr Dent* 16: 10-18, 2006.
17. Chu CH, Ho PL, Lo ECM. Oral health status and behaviours of preschool children in Hong Kong. *BMC Public Health* 12: 1-8, 2012.
18. Tham R, Bowatte G, Dharmage SC, et al. Breastfeeding and the risk of dental caries: a systematic review and meta-analysis. *Acta Paediatrica* 104: 62-84, 2015.
19. Vietnam multiple indicator cluster survey 2014. https://www.unicef.org/vietnam/resources_24623.html. Accessed December 27, 2016.
20. Karjalainen S, Soderling E, Sewon L, Lapinleimu H, Simell O. A prospective study on sucrose consumption, visible plaque and caries in children from 3 to 6 years of age. *Community Dent Oral Epidemiol* 29: 136-142, 2001.
21. Cariño KMG, Shinada K, Kawaguchi Y. Early childhood caries in northern Philippines. *Community Dent Oral Epidemiol* 31: 81-89, 2003.
22. Johansson I, Holgerson PL, Kressin NR, Nunn ME, Tanner AC. Snacking habits and caries in young children. *Caries Res* 44: 421-430, 2010.
23. Warren JJ, Levy SM, Nowak AJ, Tang S. Non-nutritive sucking behaviors in preschool children: a longitudinal study. *Pediatr Dent* 22: 187-191, 2000.
24. Uwaezuoke SN, Ilwchukwu IG, Okafor HU. Digit-sucking habit of preschool children in Enugu, Eastern Nigeria. *J Pediatr Neurol* 1: 99-101, 2003.
25. Yonezu T, Yakushiji M. Longitudinal study on influence of prolonged non-nutritive sucking habits on dental caries in Japanese children from 1.5 to 3 years of age. *Bull Tokyo Dent Coll* 49: 59-63, 2008.
26. Shelton PG, Berkowitz RJ, Forrester DJ. Nursing bottle caries. *Pediatrics* 59: 777-778, 1977.
27. Kolawole KA, Folayan MO, Agbaje HO, et al. Digit sucking habit and association with dental caries and oral hygiene status of children aged 6 months to 12 years resident in semi-urban Nigeria. *PLoS One* 11: e0148322, 2016.
28. Slabsinskiene E, Milciuviene S, Narbutaite J, et al. Severe early childhood caries and behavioral risk factors among 3-year-old children in Lithuania. *Medicina (Kaunas)* 46: 135-141, 2010.
29. Pine CM, McGoldrick PM, Burnside G, et al. An intervention programme to establish regular toothbrushing: understanding parents' beliefs and motivating children. *Int Dent J Suppl Creating A Successful*: 312-323, 2000.
30. Zhang S, Liu J, Lo EC, Chu CH. Dental caries status of Bulang preschool children in Southwest China. *BMC Oral Health* 14: 16, 2014.
31. Dawani N, Nisar N, Khan N, Syed S, Tanweer N. Prevalence and factors related to dental caries among pre-school children of Saddar town, Karachi, Pakistan: a cross-sectional study. *BMC Oral Health* 12: 59, 2012.
32. Rosenblatt A, Stamford TC, Niederman R. Silver diamine fluoride: a caries "silver-fluoride bullet". *J Dent Res* 88: 116-125, 2009.
33. Llodra JC, Rodriguez A, Ferrer B, Menardia V, Ramos T, Morato M. Efficacy of silver diamine fluoride for caries reduction in primary teeth and first permanent molars of schoolchildren: 36-month clinical trial. *J Dent Res* 84: 721-724, 2005.