Prevalence of early childhood caries and its related risk factors in preschoolers: result from a cross sectional study in Vietnam

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Abstract

Background: Dental caries is one of the most common oral diseases in humans worldwide. The methods for diagnosis and treatment of this health issue have being improved. However, dental caries, especially early childhood caries (ECC), is still a serious health problem in developing countries such as Vietnam.

Methods: To identify the prevalence, severity and associated risk factors of ECC of 4 years old children in 19.5 Thai Nguyen kindergarten in Vietnam, a cross-sectional study of 369 4-year-old children was conducted. Each child was received an oral examination using DIAGNOdent pen for caries detection. Information about associated factors was collected by face-to-face interviewing of caregivers using a structured questionnaire. Multiple linear regression was used to determine risk factors of ECC.

Results: The prevalence of ECC was 91.9% with a mean dmfs of 11.6 ± 13.3 (a mean dmft of 6.7 ± 4.7). Furthermore, 64% of the total children had severe ECC(S-ECC); 22.5% had enamel caries, 50.4% had deep enamel caries; and 77% had dentin caries. There were statistically significant associations between ECC and gender ($p = 0.005$), birth weight ($p = 0.028$), habit of dental visits ($p = 0.015$), age at start of brushing ($p = 0.009$), brushing before bed ($p = 0.013$), history of baby bottle ($p < 0.001$), and debris index ($p<0.001$).

Conclusions: The data suggests that prevalence and severity of ECC in this group were very high. Gender, birth weight, habit of dental visits, age at start of brushing, brushing before bed, history of baby bottle, debris index were suggested as risk factors of ECC.

Keywords*:* Early childhood caries; DIAGNOdent; caries detection; associated risk factors**.**

Running title: Early childhood caries and risk factors in preschoolers

1. Introduction

Dental caries is one of the most common oral diseases and it occurs in all age groups [1]. Controlling dental caries are improved; however, early childhood caries is still a serious matter of public health in both developed and developing countries [2]. In the United States, 28% of 2-5 year old children had

dental caries whose untreated decayed or filled tooth surfaces were 72%, although this disease was a preventable disease [2]. Etiology and related factors of ECC were similar to dental caries in generally. Besides, there were some special factors related to ECC such as dental defects; the injection of *Streptococcus mutans* from caregivers; and the wrong childcare methods [3-5].

The rapid development of ECC with the property in teeth usually led to tooth loss and bad effect on children's chewing, pronouncing and social communication ability. Moreover, Greenwell AL et al. pointed that 84% of children who were caries-free in the primary dentition remained so in the mixed dentition [6]; therefore, prevention and early treatment of ECC significantly contributed to improve children's oral health as well as overall health. Recently modern caries detecting devices such as DIAGNOdent have helped clinicians to provide more accurate diagnosis at early stage (before the formation of the cavity) [7]. DIAGNOdent is a caries detection tool which has been used around the world for years. It works by generating laser light with a wavelength of 655 nm. The laser light is absorbed by both organic and inorganic materials in the tooth and reemitted as fluorescence within the infrared region and that light can be analyzed and quantified. Decay process alters the amount of fluorescence, the greater the loss of mineral, the higher diagnodent index. DIAGNOdent's accuracy has been studied both *in vitro* and *in vivo* for occlusal caries in primary and permanent teeth. Virajsilp V et al reported that the reliability of DIAGNOdent was very high and its diagnostic validity (sum of sensitivity and specificity) was higher than that of bitewing radiography for proximal caries detection in primary teeth [8]. These advances have led to many changes in prevention and treatment of dental caries, especially ECC.

The **aim of this study** is to identify the prevalence and severity of ECC and to assess the associated factors on 4-year-old children in 19.5 Thai Nguyen kindergarten. Thai Nguyen city is a cultural and educational center of the North East mountainous area of Vietnam. Recently, the health care, especially dental care for young children in this city has received more attention from parents. This research is significant to planning and management of dental treatment for preschoolers.

2. Materials and methods

2.1. Study participants

A cross-sectional study was carried out in 19.5 Thai Nguyen kindergarten from January 2016 to March 2016. This is the biggest kindergarten in Thai Nguyen with children of diverse ethnicities, cultures and religions. The estimation of sample size was calculated based on formula for cross-sectional study using expected proportion of 81.6% ECC [9] at 5% type I error and precision of 5%. Simple random sampling was used to select the participants. A sample of 369 4-year-old children who presented on the examination day with no history of facial trauma or abnormal development, and caregivers who were willing to participate were eligible for the study.

2.2. Clinical examination

Dental examinations were performed by a dentist who did not know the result of interviewing. This dentist showed qualification and had been through our strict training process of using DIAGNOdent pen as manufacturers' instruction. Furthermore, the use of DIAGNOdent pen was complied with the manufacturers' instruction and adjusted differently for each individual. After cleaning, each tooth surface was examined using probes and dental mirrors with standard light to determine cavitated caries (Demineralization extends into the dentin). Then, teeth surfaces without cavity were dried, examined using laser fluorescence technology via DIAGNOdent pen 2190 (DIAGNOdent pen 2190 – Kavo, Germany) in order to determine dental caries at early stage.. The DIAGNOdent pen 2190 comes with two types of fiber optic tips, A and B. Tip A is a tapered one that using for fissure caries diagnosis and tip B is a flat one that using for smooth surface caries diagnosis. The results were recorded using the scores as stated by the manufacturer [10] shown in Table 1. To calibrate the results, for each examination, 10 percent of sample (39 children) was re-examined to ensure the consistency of the results. KAPPA score was excellent (0.86).

ECC was defined by AAPD (2008) (American Academy of Pediatric Dentistry). Accordingly, the disease of ECC was the presence of one or more decayed (noncavitated or cavitated lesions), missing (due to caries), or filled tooth surfaces in any primary tooth in a child under the age of six. In children younger than three years of age, any sign of smooth-surface caries was indicative of severe early childhood caries (S-ECC). From ages three to five, one or more cavitated, missing (due to caries), or filled smooth surfaces in primary maxillary anterior teeth or a decayed, missing, or filled score of greater than or equal to four (age 3), greater than or equal to five (age 4), or greater than or equal to six (age 5) surfaces also constituted S-ECC [11].

Debris was recorded as described by Greene and Vermillion (1964). The presence of plaque was verified on the buccal surface of 6 index teeth: the upper right second deciduous molar (tooth 55), the upper right central deciduous incisor (tooth 51), the upper left second deciduous molar (tooth 65), the lower right second deciduous molar (tooth 85), the lower left central deciduous incisor (tooth 71), and the lower left second deciduous molar (tooth 75). The tooth surface covered by debris was estimated by visual examination according to the following criteria: 0 (no debris or stain present), 1 (soft debris covering not more than 1/3 of the tooth surface), 2 (soft debris covering more than1/3 but not more than 2/3 of tooth surface), 3 (sofl debris covering more than 2/3 of the tooth surface). The total Debris Simplified-Index score was calculated and last later dichotomized into debris absent (total score = 0) or debris present (total score ≥ 1) [12].

2.3. Identification of risk factors

Face to face interviewing of caregivers using a structured questionnaire was carried out by three trained investigators who were blinded of dental caries status. The questionnaire included information on general characteristics, socio-demographic factors, anthropometric factors (weight by age; height by age; weight by height), birth history indicators, history of dental visits, oral hygiene habit (age start of brushing; daily brushing; brushing before bed; controlling brushing of parents; toothpaste with fluoride; using mouthwash; using dental floss), used systemic fluoride supplement, feeding habit (history of baby feeding; frequency of snacks; time of main meals), dental caries of mother.

2.4. Statistical analysis

Data was analyzed using Statistical Package for the Social Sciences (SPSS) 16.0. Caries experience was determined using two measures: the deciduous decayed, missing and filled surfaces (dmfs) score, the deciduous decayed, missing and filled teeth and the proportion of children who had ECC. The dmfs was calculated for each child by adding all surfaces with carious lesions (either currently carious or filled, implying previous caries). Multiple linear regression was used to determine risk factors of ECC (dmfs). Each candidate risk variable was evaluated after adjusting for the other candidate risk variables and for potential confounding variables. In the stepwise multiple linear regression analysis, $p < 0.05$ was used as the inclusion criteria while $p > 0.10$ was the exclusion criteria. Significance for all tests was established at a p-value < 0.05.

2.5. Ethics

A total of 369 pairs of child and parents was enrolled into this study after returning informed written consent. The study was carried out along with the annually health examination for children at the public health room of 19.5 Thai Nguyen kindergarten. The process of examinations was ensured principle of sterilizing. The personal information was kept secretly. After oral examinations, each child and their parents were given prevention and treatment recommendations due to the child status. The tooth caries was filled if the parents approved the treatment.

3. Results

3.1. Prevalence of dental caries in 4 years old children

Among studied subjects, 52.6% of participants were males and 47.4% were females, mostly were Kinh ethnic (85.1%). Table 2 showed that the prevalence of ECC were very high (91.9%). Moreover, about two-third of children had severe early childhood caries (S-ECC). On average, each child had 11.6 decayed or filled surfaces due to caries and no missing teeth. The highest number of decayed, untreated surfaces in a child was 88 (counted on both dental arches). According to the teeth, each child in this study had 6.7 decay or filled teeth. More than a haft of children had caries at early stage (Enamel caries and deep enamel caries), and about three-fourths of children had caries at later stage (Dentin caries).

ECC occurred mostly at mandibular and maxillary molars, followed by maxillary anterior teeth and mandibular anterior teeth (Figure 1).

The prevalence of associated factors such as having no dental checkup, starting to brush when all primary teeth spouted, no using of dental floss, no using of systemic fluoride supplement, eating many snacks, having debris on teeth were high (Table 3).

3.2. Associated risk factors of ECC

Multiple linear regression analysis was used to determine risk factors od ECC controlling for socio-demographic, anthropometric factors (weight by age; height by age; weight by height), birth history indicators, history of dental visits, oral hygiene habits (age start of brushing; daily brushing; brushing before bed; controlling brushing of parents, toothpaste with fluoride, using mouthwash, using dental floss), nutritional cares (history of baby bottle feeding, number of snacks, time for main meals), dental caries of mother, debris on teeth. The result pointed out that gender, birth weight, habit of dental visits, age at start of brushing, brushing before bed, history of baby bottle feeding, average of Debris Simplified-Index (DI-S) associated with level of surface caries ($p < 0.05$) (Table 4). Female had 0.14 less decayed surfaces than male ($\beta = -0.137$). Children with low birth weight had 0.1 more decayed surfaces than those with normal birth weight ($\beta = 0.103$). Children visited dentists regularly had 0.12 more decayed surfaces than the children visited dentist when they had problems, and had 0.23 more decayed surfaces than the children who no ever visited dentist ($\beta = -0.115$). The later the children started brushing the more decayed surfaces they had ($\beta = 0.124$). The children who used to take bottle after 24 months had 0.5 more decayed surfaces than the children without history of baby bottle feeding ($\beta = 0.171$). Collinearity diagnostics showed no violation of the assumption of independence among these risk factors (all tolerance values > 0.9). Therefore, all regression coefficients were considered valid. The multiple linear regression models explained about 20% of the variation in caries incidence ($R^2 = 0.204$).

4. Discussion

DIAGNOdent is a simple device to use with quick results after a few seconds and does not need a lot of cooperation from the child. The most reason for using DIAGNOdent in clinical is no harm for child. DIAGNOdent is an appropriate device for detection of demineralization processes in smooth enamel lesions. Because of special characteristics of deciduous teeth (having milk color and larger contact area…) so using laser fluorescence devices in examination as in this study provided more accurate dental caries detection at very early stage. Several studies indicated that DIAGNOdent was an appropriate modality for caries detection as a complementary method beside other methods [7].

In this study, most of 4 years old children (91.9%) had experience of ECC. On average, each child had nearly 12 decayed surfaces (dmfs = 11.6 ± 13.3). Especially, 64% of the children had S-ECC. This prevalence was higher than prevalence of ECC at the same age group found in other studies in Vietnam. For example, study of Dung TM et al with classification of dental caries according to WHO-1997 showed the prevalence of dental caries on primary teeth was 81.6% at age group of 4 to 8 years old [13]. Study of Tuan VM et al. followed criteria of ICDAS II (2005) also using laser fluorescence technology to support caries detection and found that 79.7% of 3-year-old children had ECC and the mean dmfs was 11.1 [13]. Moreover, study done by Cabral RN et al. in 5 to 7 years old children living in a rural area in Brazil showed higher prevalence of ECC (98.6%) but lower mean dmfs (3.4 ± 4.5) [14]. Those differences may due to the differences in criteria of caries detection and diagnosis as well as the age of studied groups.

In addition, more than a haft of children had caries into enamel (22.5% enamel caries and 50.4% deep enamel caries), and three-fourths of children had the dentin caries which include the dental caries into dentin and the dental caries out of dentin (extending to the pulp) (77.0%). That suggested the necessity of developing preventive strategies and oral care to fit this target group.

The distribution of ECC prevalence in this study decreased from mandibular molars to maxillary molars; maxillary anterior teeth and mandibular anterior teeth. Moreover, approximately 10% of children had dental caries on mandibular incisors. The percentage of second molars with dental caries was very high and mostly was untreated. These results urged an effective oral care strategy for children in this age group because of the second primary molars play an important role in chewing and orientating the occlusal formation in mixed and permanent dentition in near future (10-12 years old).

In order to find the risk factors related to ECC, multiple linear regression statistical analysis was used controlling for socio-demographic, anthropometric factors (weight by age; height by age; weight by height), birth history indicators, history of dental visits, oral hygiene habit (age start of brushing; daily brushing; brushing before bed; controlling brushing of parents, toothpaste with fluoride, using mouthwash, using dental floss), nutritional care (history of baby bottle feeding, number of snacks, time for main meals), dental caries of mother, and debris on teeth. The result pointed that gender, newborn weight, the habit of dental visits, the age start of brushing, brushing before bed, history of baby bottle feeding and debris index statistically associated with ECC.

This study showed that children with low birth weight had higher risk of dental caries than the children not low birth weight (p=0.028). There was not high degree of unanimity about the relationship between birth weight and ECC in previous studies [5, 15, 16]. Prematurity and low birth weight might cause long-term illness and disability, including developmental delays, chronic respiratory problems, vision and hearing impairment. Low birth weight also predisposed to high levels

of *streptococcal colonization* due to the reducing of immune function and favoring the development of enamel hypoplasia and salivary disorders [17].

This study also emphasized the importance of early oral hygiene right after the first primary tooth eruption to prevent dental caries. This was similar to other studies [11, 18]. The results also showed that the children who started brushing at the eruption of 1st primary tooth had less decayed surfaces than the children who started brushing later ($p = 0.009$) and the children without brushing before bed had more decayed surfaces than the children with brushing before bed ($p = 0.013$).

Debris Simplified-Index is a simple and effective method for assessing group or individual oral hygiene practice. It was recommended that this method should be used in prospective studies of caries activity [18]. In this study, the group of children with dental caries had higher average of Debris Simplified-Index than the group of children without dental caries. The difference was statistically significant ($p < 0.05$). For these reasons, in order to the prevention of ECC we need to start oral hygiene practices no later than the time of eruption of the first primary tooth, do tooth brushing before bed and pay the attention to the efficiency of the oral hygiene.

AAPD stated that parents should let the infants drink from a cup when they reach their first birthday and the infants should stop bottle feeding between 12 to 18 months of age [11]. However, 46.6% children had history of bottle feeding after 12-month-age in this study. The results also showed that the longer the children got bottle feeding, the more decayed surfaces they got. There were statistically significant differences in the fours bottle feeding groups with regards to ECC ($p < 0.001$). The nutritional recommendations are also needed to be given in order to prevent dental caries.

5. Conclusions

The prevalence of dental caries of 4 years old children in 19-5 Thai Nguyen kindergarten was very high (91.9%) and mean dmfs was 11.6 ± 13.3 (a mean dmft was 6.7 ± 4.7). 64% of the total subjects had S-ECC; 22.5% had enamel caries, 50.4% had deep enamel caries (non-cavitated lesions at early stage dental caries); 77.0% had dentin caries (cavitated lesion at later stage dental caries).

Multiple linear regression suggested that the risk factors of ECC were gender ($p = 0.005$), low birth weight ($p = 0.028$), history of dental visit ($p = 0.015$), the age start of brushing ($p = 0.009$), brushing before bed ($p = 0.013$), history of baby bottle feeding ($p <0.001$) and Debris Index ($p<0.001$).

Conflict of interest

The authors declare that they have no conflict of interest

Ethics statement

All study protocols were approved by the Thai Nguyen University of Medicine and Pharmacy Ethical Committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments.

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Table 1. DIAGNOdent pen values and corresponding diagnosis

Values DIAGNOdent pen	Diagnosis
0 to 13	Healthy tooth
14 to 20	Enamel caries
21 to 29	Deep enamel caries
≥ 30	Dentin caries

Table 2. The prevalence of ECC

Indicators	n (%)	decayed, missing and filled ($\bar{X} \pm SD$)							
		dmfs	ds	ms	fs	dmft	dt	mt	ft
ECC	339 (91.9)	11.6 ± 13.3	11.1 ± 12.9	0	0.5 ± 1.7	6.7 ± 4.7	6.5 ± 4.6	0	0.2 ± 0.7
S-ECC	236 (64.0)	17.0 ± 13.9	16.1 ± 13.5	0	0.8 ± 2.0	9.3 ± 3.9	8.9 ± 3.9	0	0.3 ± 0.9
Enamel caries	83 (22.5)	0.3 ± 0.7				0.3 ± 0.7			
Deep enamel caries	186 (50.4)	1.6 ± 2.7				1.3 ± 1.7			
Dentin caries	284 (77.0)	9.2 ± 12.9				4.9 ± 4.8			

Table 3. The prevalence of potential associated factors of ECC

Indicators	n	%	$(\bar{X} \pm SD)$
Gender			
Male	194	52.6	
Female	175	47.4	
Birth weight			
Normal (≥2500gr)	361	97.8	
Low (<2500gr)	8	2.2	
Gestational age			
Normal (≥ 37 weeks)	325	88.1	
Low (< 37 weeks)	44	11.9	
BMI by age			
Normal	334	90.5	
Obese	35	9.5	
Height by age			
Normal	352	95.4	
Low	17	4.6	
Weight by age			
Normal	361	97.8	
Low	8	2.2	
Weight by height			
Normal	367	99.5	
Low	2	0.5	
History of dental visits			

Regular	25	6.8	
When have problems	98	26.6	
No ever	246	66.7	
Age at start of brushing			
First erupted primary tooth	60	16.3	
Several deciduous teeth erupted	109	29.5	
All deciduous teeth erupted	200	54.2	
Frequency of brushing			
≥ 2 times a day	155	42.0	
1 times a day	183	49.6	
No regular	31	8.4	
Age at brushing with parents controlling			
≥ 3 years old	79	21.4	
2 – 3 years old	172	46.6	
≤ 2 years old	118	32.0	
Used toothpaste with fluoride			
Yes	314	85.1	
No	55	14.9	
Brushing before bed			
Daily	147	39.8	
Irregular	154	41.7	
No ever	68	18.4	
Used mouthwash			
Daily	118	32.0	
Irregular	146	39.6	
No ever	105	28.5	
Using dental floss			
Daily	14	3.8	
Irregular	26	7.0	
No ever	329	89.2	
Used systemic fluoride supplement			
Yes	38	10.3	
No	331	89.7	
History of baby bottle feeding			
No	178	48.2	
Under 12 months	19	5.1	
12 – 24 months	115	31.2	
≥ 24 months	57	15.4	
Frequency of snacks			
Low (≤2)	158	42.8	
High (≥3)	211	57.2	
Time of main meals			
< 30 minutes	137	37.1	
30 – 60 minutes	213	57.7	
> 60 minutes	19	5.1	
Dental caries of mother			
No	251	68.0	
Yes	118	32.0	
Debris on teeth			
No	63	17.1	
Yes	306	82.9	
DI-S			0.8 ± 0.5

Table 4. Multiple linear regression models of ECC (dmfs) incidence among 369 children

Risk factor for caries	Standardized coefficient (β)	p-value	Collinearity	
			Tolerance	Variance inflation factor
Gender[a]	-0.137	0.005*	0.946	1.057
Birth weight[b]	0.103	0.028*	0.992	1.008
History of dental visits[c]	-0.115	0.015*	0.979	1.021
Age at start of brushing[d]	0.124	0.009*	0.970	1.031
Brushing before bed[e]	0.121	0.013*	0.921	1.086
DI-S[f]	0.317	<0.001*	0.982	1.019
History of baby bottle feeding[g]	0.171	<0.001*	0.959	1.043

Adjusted R^2 = 0.204; p-model < 0.0001

[a] Male = 0; female = 1.

[b] Normal = 0; Low = 1.

[c] Regular = 0; when have problems = 1; No ever = 2.

[d] upper 3 years old = 0; 2 – 3 years old = 1; under 2 years old = 2

[e] Daily = 0; Irregular = 1; No ever = 2

[f] Average of Debris Simplified-Index

[g] No = 0; under 12 months = 1; 12 – 24 months = 2; upper 24 months = 3

* Multiple linear regression controlling for socio-demographic, anthropometric factors (weight by age; height by age; weight by height), birth history indicators, history of dental visits, oral hygiene habit (age start of brushing; daily brushing; brushing before bed; controlling brushing of parents, toothpaste with fluoride, using mouthwash, using dental floss), nutritional care (history of baby bottle feeding, number of snacks, time for main meals), dental caries of mother, debris on teeth.

Figure and its legend

Figure 1. Distribution of ECC by type of primary tooth (n = 369)