FACTORS ASSOCIATED WITH EARLY CHILDHOOD CARIES AMONG CHILDREN LIVING IN SUGAR PALM PLANTATION COMMUNITIES, PHETCHABURI PROVINCE, THAILAND

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Abstract. Early childhood caries (ECC) is a common problem in Thailand. In this study, we aimed to determine factors associated with ECC among children aged 3 years living in sugar palm plantation communities in Phetchaburi Province, Thailand in order to inform efforts to prevent ECC in this study population. Study participants were children aged 3 years who presented to any one of 11 Primary Healthcare Centers or 1 Community Hospital serving sugar palm plantation communities in Phetchaburi Province for medical care during February-April 2020. These children were divided into cases and controls with a ratio of 1:1 and the two groups were compared to obtain our study results. Cases were defined as children who had a decayed, missing and filled teeth (DMFT) index >0 based on an oral examination by a dental hygienist. Controls were children who had a DMFT index = 0. Cases and controls were both gender-matched. Cases were divided into groups by severity of ECC by DMFT score, where: a DMFT score of 1-2 was defined as a mild case, a DMFT score of 3-4 as a moderate case and a DMFT score of >4 as a severe case. The caregiver of each subject was interviewed using a questionnaire asking about demographic characteristics, breast- and bottle-feeding history, toothbrushing practices, use of fluoridated toothpaste, history of having a fluoride varnish and consumption of foods or beverages containing sugar. We compared cases and controls using conditional logistic regression analysis. A total of 171 cases and 171 controls were included in the study with 96 females in each group of cases and controls. 28.1%, 26.9% and 45.0% of cases had mild, moderate and

severe ECC, respectively. The factor significantly positively associated with developing ECC was consuming food or beverages containing sugar (adjusted odds ratio (aOR) = 2.0; 95% CI: 1.2-3.3; p=0.006) and the factor significantly negatively associated with developing ECC was subject toothbrushing by the caregiver (aOR = 0.3; 95% CI: 0.1-0.6; p=0.001). In summary, the factor significantly positively associated with ECC was consuming food or beverages containing sugar. The factor significantly negatively associated with ECC was subject toothbrushing by the caregiver. We conclude, programs to reduce ECC in the study population need to limit consumption of sugary foods and beverages and encourage caregivers to brush their child's teeth or supervise their toothbrushing. Further studies are needed to determine how best to conduct these education programs, what the current prevalence of ECC in the study population is and after the program intervention what the prevalence of ECC is in order to evaluate its efficacy.

Keywords: early childhood caries, sugar palm, Phetchaburi, Thailand

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INTRODUCTION

The prevalence of early childhood caries (ECC) is increasing rapidly in low- and middle-income countries (WHO, 2019). The prevalence of ECC have been reported to be greater in Southeast Asia than in many other countries of Asia. Duangthip *et al* (2017) reported the prevalence of ECC to be 25-75% in Myanmar, 62-95% in Vietnam, 89% in Laos, 79% in Thailand, 91-93% in Cambodia, 59% in Brunei and 75% in Malaysia. Watanabe *et al* (2014) reported the prevalence of ECC to be 17% in Japan. Han *et al* (2014) reported the prevalence of ECC to be 47% in South Korea. Tan *et al* (2021) reported the prevalence of ECC to be 31% in Singapore. In Thailand, the prevalence of ECC among children aged 5-6 years during 2017-2022 has been reported by multiple studies to be ≥70% (Mitrakul *et al*, 2017; Petersen

et al, 2020; Boonyawong *et al*, 2022).

Primary healthcare plays an important role in preventing ECC. Early diagnosis, regular prevention with fluoride varnish (FV), health education and community engagement by primary care teams and community health workers have been recommended to control and prevent ECC (WHO, 2019). A study from Chile found delivering dental services through community programs was financially effective (Mariño *et al*, 2012). Therefore, health professionals can detect early caries lesions and refer the child for proper treatment since caries lesions progress faster in primary teeth than in permanent teeth (WHO, 2019). Therefore, appropriate health education can reduce the prevalence of ECC (Hoeft *et al*, 2015).

Familial and individual behaviors reported to be associated with developing ECC include infant feeding practices (Tanaka *et al*, 2013; Hong *et al*, 2014), use of fluoride (fluoridated toothpaste or application of FV) (Watanabe *et al*, 2014); diet (Mitrakul *et al*, 2017), consumption of sugary foods (Kirthiga *et al*, 2019; Watanabe *et al*, 2014), consumption of snacks and sodas (Han *et al*, 2014) and someone smoking in the family (Mosharrafian *et al*, 2020).

Phetchaburi Province, Thailand is known for its sugar palm (*Arenga pinnata*) plantations (URL: https://en.wikipedia.org/wiki/Phetchaburi_province) and production of sugary foods and beverages. The province has been included in oral health surveys conducted by the Thai government due to its sugar production (Division of Dental Health - Ministry of Public Health, 2018). This is the reason why we selected this province for our study.

In this study, we aimed to determine factors associated with ECC among children aged 3 years living in sugar palm plantation communities in Phetchaburi Province, Thailand in order to inform efforts to prevent ECC in this study population.

MATERIALS AND METHODS

Study subjects

We randomly selected study subjects aged 3 years who presented for medical care to any one of 8 Primary Health Centers (PHC) or 1 Community Hospital (CH) in Tha Yang District, Phetchaburi Province, Thailand during February-April 2020 and met the following inclusion

criteria: having an oral record showing their decayed, missing and filled teeth (DMFT) index and parental consent for participation. The exclusion criteria for subjects were having a congenital oral problem, cerebral palsy, diabetes or other disease affecting their oral hygiene.

Subject examination

Each subject had an oral examination by a dental hygienist following World Health Organization guidelines (WHO, 2013) to ascertain their DMFT index. The dental hygienist had been trained by the Division of Dental Health (Division of Dental Health - Ministry of Public Health, 2018). The severity of ECC was classified as mild (DMFT 1-2), moderate (DMFT 3-4) or severe (DMFT ≥5).

Subjects were divided into cases and controls with a ratio of 1:1, where a case was defined as a DMFT score >0 and controls as a DMFT score =0. The case and control groups were gender matched.

Questionnaire

The caregiver of each participant was interviewed using a standardized questionnaire. The questionnaire was modified from the 8th Thailand National Oral Health Survey (TNOHS) (Division of Dental Health - Ministry of Public Health, 2018). The questionnaire asked about subject characteristics (gender; birth order; and birth weight), caregiver characteristics (maternal age during pregnancy, family smoking, parental education level, parental employment status and household income), breast-, and bottle-feeding in the past 6 months, nighttime feedings, toothbrushing, use of fluoridated toothpaste, toothbrushing by caregiver, number of FV applications during the previous 3 years, consumption of sweet snacks, consumption of beverages and foods containing sugars including locally produced palm sugar products and desserts.

Added questions not included on the TNOHS were checked for clarity and accuracy (content validity index of 0.85) prior to use.

Sample size

The minimal number of study subjects was determined using a matched case-control formula described previously (Dupont, 1988) and to determine the ability of FV to prevent ECC by 50% (Weintraub *et al*, 2006). The calculation assumed a type I error of 5%, a power of 80% and

a non-response rate of 20% giving a total of 171 subjects in each group of cases and controls.

Statistical analysis

Categorical variables were described using frequencies and percentages. Factors potentially associated with ECC were at first assessed using conditional bivariate logistic regression analysis and those with significant findings where $p \leq 0.10$ then evaluated using conditional multivariate logistic regression analysis. The final model was adjusted to reduce confounding factors. We calculated adjusted odds ratios (aOR) and 95% confidence intervals (CI) A *p*-value <0.05 was considered statistically significant. All analyses were performed using STATA Version 17 (STATA Corp, College Station, TX).

Ethical consideration

Parental consent was obtained from each subject prior to inclusion in the study. Ethical approval of the study protocol was obtained from the Mahidol University Ethics Committee (Certificate of Ethical Approval No. MUPH 2019-15) and Phetchaburi Provincial Health Office Ethics Committee (KJM.PB 003/2020).

RESULTS

General characteristics

A total of 171 cases and 171 controls were included in the study with 96 females included in both cases and controls. Among the cases, the profile of ECC severity were: 28.1% mild; 26.9% moderate; and 45.0% severe (95% CI: 37.4-52.8).

There were no significant differences between cases and controls for household monthly income, caregiver education levels, caregiver employment status, maternal age during pregnancy, parental smoking status, access to fluoridated water, childbirth order and subject birth weight (Table 1).

Diet and feeding

There were no significant differences between cases and controls for diet, breast-feeding history, age at first consuming food or beverages containing sugar, consumption of palm sugar dessert or snacking during the previous 6 months.

67.3% of cases and 52.6% of controls consumed sugary food or beverages during the previous 6 months (p=0.005); and 8.8% of cases and 1.8% of controls consumed palm sugar juice ≥4 times per week (p=0.011).

Table 1

General characteristics of subject and their caregivers

Variables	Frequency, *n* (%)			*p*-value
	Total N = 342	Cases N = 171	Controls N = 171	
Birth order				
First	185 (54.1)	93 (54.4)	92 (53.8)	0.913
Other	157 (45.9)	78 (45.6)	79 (46.2)	
Birthweight in grams				
<2500	26 (7.6)	14 (8.2)	12 (7.0)	0.670
≥2500	316 (92.4)	157 (91.8)	159 (93.0)	
Household income per month (THB)				
<10,000	97 (28.4)	48 (28.1)	49 (28.7)	0.693
≥10,000	245 (71.6)	123 (71.9)	122 (71.3)	
Education level of caregiver				
≤Secondary	221 (64.6)	118 (69.0)	103 (60.2)	0.110
>Secondary	121 (35.4)	53 (31.0)	68 (39.8)	
Employment status of caregiver				
Unemployed	24 (7.0)	9 (5.3)	15 (8.8)	0.207
Employed	318 (93.0)	162 (94.7)	156 (91.2)	

Table 1 (cont)

Variables	Frequency, *n* (%)			*p*-value
	Total N = 342	Cases N = 171	Controls N = 171	
Age of subject mother during pregnancy				
13-25 years	138 (40.5)	68 (39.8)	70 (41.2)	0.827
>25 years	203 (59.5)	103 (60.2)	100 (58.8)	
Maternal smoking history				
Yes	6 (1.8)	4 (2.3)	2 (1.2)	0.423
No	335 (98.2)	167 (97.7)	168 (98.8)	
Family smoking history				
Yes	180 (52.8)	93 (54.4)	87 (51.2)	0.588
No	161 (47.2)	78 (45.6)	83 (48.8)	
Access to fluoridated water				
Yes	266 (77.8)	137 (80.1)	129 (75.4)	0.303
No	76 (22.2)	34 (19.9)	42 (24.6)	

THB: Thai baht (approximately 32 THB = 1 US dollars)

There were no significant differences between cases and controls for snack consumption history, breast-feeding history, age at weaning from bottle-feeding and nighttime bottle-feeding behavior (Table 2).

Oral hygiene and fluoride varnish application

17.5% of cases and 27.1% of controls (p=0.022) initiated toothbrushing when aged 12-24 months. 80.7% of cases and 93.6% of controls (p=0.001) had their teeth brushed daily by their caregiver. 97.1% of cases and 91.3% of controls (p=0.027) brushed their teeth at least twice daily. 9.9% of cases and 18.1% of controls (p=0.014) began using fluoride toothpaste before age 12 months. 63.7% of cases and 75.4% of controls (p=0.016) had FV applied at least once in the previous 3 years (Table 3).

Factors significantly associated with DMFT scores

On conditional multivariate logistic regression analysis, the factor significantly positively associated with a DMFT score >0 was regular consumption of food or beverages containing sugar in the previous 6 months (aOR = 2.0; 95%CI: 1.2-3.3; p=0.006) and the factor significantly negatively associated with a DMFT score >0 was toothbrushing by a caregiver (aOR = 0.3; 95%CI: 0.1-0.6; p=0.001) (Table 4).

DISCUSSION

In our study, consumption of sugary food or beverages during the previous 6 months was significantly positively associated with a DMFT score >0, similar to the findings of other studies (Kirthiga *et al*, 2019; Watanabe *et al*, 2014; Ghazal *et al*, 2015). However, a previous study from northern Thailand (Peltzer and Mongkolchati, 2015) did not find a significant association between consuming sugary foods and beverages and the presence of ECC. A possible reason for this finding was the study focused on severe ECC, not overall ECC, including mild cases. The WHO has reported consumption of sugars increases the risk for developing ECC (WHO, 2015; WHO, 2019).

In our study, toothbrushing was significantly negatively associated with a DMFT index >0, similar to a previous study from India (Prakash *et al*, 2012) which reported finding a significantly lower prevalence of ECC among children who brushed their teeth under caregiver supervision.

Table 2

Dietary behavior, breast-feeding and bottle-feeding history among study subjects

Variables	Frequency, *n* (%)			*p*-value
	Total N = 342	Cases N = 171	Controls N = 171	
Age in months first consuming food containing sugar				
Never/≤12	118 (34.5)	63 (36.8)	55 (32.2)	0.378
>12	224 (65.5)	108 (63.2)	116 (67.8)	
Age in months first consuming a beverage containing sugar				
Never/≤12	98 (28.7)	48 (28.1)	50 (29.2)	0.814
>12	244 (71.3)	123 (71.9)	121 (70.8)	
Snacking in previous 6 months				
Between breakfast and lunch	59 (17.2)	36 (21.0)	23 (13.4)	0.077
Other times	283 (82.8)	135 (79.0)	148 (86.6)	
Consumption of food or beverages containing sugar in the previous 6 months				
<4 times/week	137 (40.1)	56 (32.3)	81 (47.4)	0.005
≥4 times/week	205 (59.9)	115 (67.3)	90 (52.6)	

Table 2 (cont)

Variables	Frequency, *n* (%)			*p*-value
	Total N = 342	Cases N = 171	Controls N = 171	
Consumption of palm sugar dessert				
<4 times/week	308 (90.1)	149 (87.1)	159 (93.0)	0.065
≥4 times/week	34 (9.9)	22 (12.9)	12 (7.0)	
Consumption of palm sugar juice				
<4 times/week	324 (94.7)	156 (91.2)	168 (98.2)	0.011
≥4 times/week	18 (5.3)	15 (8.8)	3 (1.8)	
Snacks consumption history				
0-3 times/week and began age ≤12 months	62 (28.1)	21 (12.3)	41 (24.0)	0.652
0-3 times/week and began age >12 months	65 (19.0)	36 (21.0)	29 (17.0)	
≥4 times/week and began age ≤12 months	124 (36.3)	64 (37.4)	60 (35.1)	
≥4 times/week and began age >12 months	91 (26.6)	50 (29.2)	41 (24.0)	
Duration of breast-feeding				
0–5 months	156 (45.6)	73 (42.7)	83 (48.5)	0.147
6-18 months	120 (35.1)	60 (35.1)	60 (35.1)	
>18 months	66 (19.3)	38 (22.2)	28 (16.4)	

Table 2 (cont)

Variables	Frequency, *n* (%)			*p*-value
	Total N = 342	Cases N = 171	Controls N = 171	
Age in months weaned from bottle-feeding				
0-18 months	99 (28.9)	43 (25.1)	56 (32.7)	0.125
>18 months	243 (71.1)	128 (74.9)	115 (67.3)	
Number of times bottle fed at night per week				
0–4	254 (74.3)	122 (71.3)	132 (77.2)	0.234
>4	88 (25.7)	49 (28.7)	39 (22.8)	

Table 3

Oral hygiene and fluoride varnish application among study subjects

Variables	Frequency, *n* (%)			*p*-value
	Total (N = 342)	Cases (N = 171)	Controls (N = 171)	
Age in months at first toothbrushing				
<12	76 (22.3)	30 (17.5)	46 (27.1)	0.022
12-24	241 (70.7)	126 (73.7)	115 (67.6)	
>24	24 (7.0)	15 (8.8)	9 (5.3)	

Table 3 (cont)

Variables	Frequency, *n* (%)			*p*-value
	Total (N = 342)	Cases (N = 171)	Controls (N = 171)	
Number of times teeth brushed daily				
<2	20 (5.8)	5 (2.9)	15 (8.7)	0.027
≥2	322 (94.2)	166 (97.1)	156 (91.3)	
Number of times per day teeth brushed by caregiver				
0	44 (12.9)	33 (19.3)	11 (6.4)	0.001
≥1	298 (87.1)	138 (80.7)	160 (93.6)	
Age in months first used fluoride toothpaste				
<12	48 (14.0)	17 (9.9)	31 (18.1)	0.014
12-24	252 (73.7)	128 (74.9)	124 (72.5)	
>24	42 (12.3)	26 (15.2)	16 (9.4)	
Number of times fluoride varnish applied in previous 3 years				
0	104 (30.4)	62 (36.3)	42 (24.6)	0.016
1–3	207 (60.5)	97 (56.7)	110 (64.3)	
≥4	31 (9.1)	12 (7.0)	19 (11.1)	

Table 4

Factor associated with a DMFT score >0 among study subjects

Variables	aOR (95% CI)	*p*-value
Consumption of food or beverage containing sugar in the previous 6 months		
<4 times/week	1.0	0.006
≥4 times/week	2.0 (1.2–3.3)	
Number of times per day teeth brushed by caregiver		
0	1.0	
≥1	0.3 (0.1–0.6)	0.001

aOR: adjusted odds ratio; CI: confidence interval; DMFT: decayed, missing and filled teeth

A study from Japan (Watanebe *et al*, 2014) also reported finding significantly more ECC among children who did not receive daily toothbrushing supervision from a caregiver. Contrary to these the findings of these studies, a study from the United States among African American children (Ghazal *et al*, 2015) reported finding no association between caregiver-assisted toothbrushing and ECC among subjects. This study only asked about toothbrushing with 2 possible answers, either yes or no. This answer may not reflect cases with variation in toothbrushing instruction by the parents or occasional toothbrushing by the subjects. The role of caregivers in relation to dental caries in primary teeth among preschool children has been well documented (WHO, 2019). The promotion of oral health literacy among families and caregivers through parental education has been found to be a key factor in establishing good oral health behaviors (Sitthisettapong *et al*, 2021). Narksawat *et al* (2011) recommended that Thai parents should be encouraged to consistently dedicate time to care for their children's primary teeth and

regularly assist with toothbrushing. The American Academy of Pediatric Dentistry (AAPD) also recommends involving the caregiver in a child's oral hygiene from the eruption of the first tooth, they recommend the caregiver examine the child's mouth and teeth for cleanness twice a day and using a pea-sized amount of fluoride toothpaste among children aged 3 years (Anonymous, 2016).

Our study had several limitations. First, the subjects were from only one district of a sugar palm plantation community and cannot be generalizable to other populations. Second, we used the DMFT score which is not a direct reflection of ECC; however, any inaccuracies would be randomly distributed between cases and controls.

Our study showed the importance of careful management of food and beverages and toothbrushing by caregivers in this study population and shows a possible need for education regarding oral health in the caregivers of this population. Further studies are needed among the caregivers of this population to determine what their knowledge of oral health is and how best to improve it. Further studies of the prevalence of ECC before and after an intervention to improve this education level are needed in order to evaluate its efficacy.

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CONFLICT OF INTEREST DISCLOSURE

The authors declared no conflicts of interest with respect to the research, authorship and/or publication of this article.

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