Risk Factors associated with Early Childhood Caries

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Objective: *To analyse factors associated with the susceptibility of early childhood caries (ECC), populations with a high risk of ECC were screened and guidance for ECC prevention was proposed.*

Methods: *A total of 392 children aged 24 to 71 months were selected for oral examination in Qingdao. Parents or guardians of the participants completed the questionnaires and decayed missing filled surface (dmfs) were recorded. Differences in caries condition and oral health behaviour in different families were compared. Risk factors related to ECC were screened. The subjects were finally grouped based on the obtained dmfs into three groups: caries-free, ECC and S-ECC (severe ECC). Association of risk factors with the caries status was analysed using the Kruskal-Wallis test, the chi-square test and logistic regression analysis.*

Results: *There were significant differences among the caries-free, ECC and S-ECC groups in three parameters: eating too many sweets each day, brushing before and after sleeping, and whether parents helped to brush ($P < 0.01$). Combined factors such as the parents' level of education, oral health knowledge, attitudes, the family's annual income, the age of children when they start to brush and not brushing regularly were also significantly related to ECC ($P < 0.05$). No significant differences were observed among the three groups for these factors, including birth condition and nursing state, physical condition of the mother during pregnancy, feeding situation, if a pacifier was used during sleep, duration of brushing, frequency of mouth rinsing after meals each day and brushing with fluoride toothpaste ($P > 0.05$).*

Conclusion: *Eating a lot of sweets, an incorrect brushing method, starting brushing at a later stage and not brushing regularly are susceptible factors for ECC. Emphasising oral health knowledge to parents and guardians, conducting proper brushing methods, limiting the frequency of sweets being eaten and avoiding an inappropriate habit of eating sweets are very important factors in the prevention of ECC.*

Key words: *children, decayed missing filled surface (dmfs), early childhood caries (ECC), prevalence, susceptibility*

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Dental caries is a chronic progressive disease in which dental hard tissues suffer from destruction under a variety of bacterial-based factors, and one of the most common oral diseases. Because of its universality, most people often ignore dental caries.

This neglect tends to increase the harm caries can cause to the human body. According to the World Health Organization, cancer, cardiovascular disease and caries are listed as three major human preventable and treatable diseases. At present, the etiological study, risk assessment and preventative strategies of dental caries are key issues in research.

Caries can occur in children and adults. There are no significant differences between them in aspects of etiology and histopathologic characteristics. However, because of the characteristics of children's growth and tooth physiology and anatomy, caries in children has its own characteristics.

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According to the American Academy of Pediatric Dentistry (AAPD)[1], early childhood caries (ECC) is the primary caries occurring before the age of 71 months, which exists in one or more decayed (non-cavitated or cavitated lesions), missing (due to caries) or filled tooth surfaces of any primary tooth. Severe early childhood caries (S-ECC) occurred in children suffering from severe caries, which includes any sign of smooth-surface caries in children younger than three years old, one or more cavitated, missing, or filled smooth surfaces in primary maxillary anterior teeth from the ages of three to five, or a decayed, missing, or filled score of ≥ 4 (age three), ≥ 5 (age four), or ≥ 6 (age five) surfaces[2]. ECC may spread to multiple primary teeth and cause pain, swelling, loss of primary teeth at an early age, malocclusion and other problems. These factors will lead to malfunctions in pronouncing words, chewing, aesthetics and a serious impact on children's health and growth[3,4]. Because host defence mechanisms during childhood are not yet mature, and the differences regarding oral bacteria' colonisation, children's oral health behaviours and dietary habits, the factors of ECC show the diversity and complexity. Nowadays, more and more risk factors have been proposed, but these are still not extremely clear.

Therefore, to identify high-risk ECC population at the earliest stage, it is necessary to study the risk factors of ECC. Accurate caries risk assessments at the population level or at the individual level (precision dentistry) are both essential and achievable, but have to be built on high-quality longitudinal materials and rigorous methodology[5]. In this study we investigated the caries status in children from 24 to 71 months of age in Qingdao and analysed risk factors associated with ECC. Our results provide important evidence for preventative guidance of ECC at an early stage.

Materials and methods

Selection and grouping of the participants

In total, 392 children from the age of 24 to 71 months (mean age 49.94 ± 7.45 months) were randomly selected from premium level private, moderate-level public and low-income kindergartens in Qingdao (208 male, 184 female). Among them, 26 were aged 24 to 36 months, 96 were 37 to 42 months, 48 were aged 43 to 48 months, 84 were 49 to 54 months, 72 were 55 to 60 months and 66 were between 61 and 71 months. Exclusion criteria included obvious oral infection and lesion, acute pharyngitis, acute tonsillitis and other systemic diseases.

All the children's parents and kindergarten teachers signed the informed consent to participate in this survey. The study was approved by the Affiliated Hospital of Qingdao University Institutional Review Board in Shandong, China.

Questionnaires

Questionnaires were designed and completed based on a children's caries research model and a cross-sectional study[6], including children's oral health behaviours and dietary habits, parental behaviours and basic family conditions.

The children's oral health behaviours and dietary habits included:

- The age at which children started to brush;
- The frequency and duration of brushing;
- The frequency of rinsing the mouth after meals daily;
- Brushing with or without fluoride toothpaste;
- Birth condition;
- The physical condition of the mother during pregnancy;
- How the child was fed;
- If the child fell asleep with a pacifier;
- The frequency of eating sweets or consuming sweet drinks;
- Eating sweets or sweet drinks before sleeping and/or after brushing.

Parental behaviours and the basic family conditions included:

- Whether or not parents helped with brushing;
- Nursing habits;
- Parental education;
- The parents' level of education;
- Oral health knowledge and attitudes;
- The family's annual income.

There were 16 study variables in total. The questionnaire reflected the children and parents' oral hygiene habits, parents' attention to oral health and the family's economic conditions. Kindergarten teachers and researchers gave out the questionnaires, which were filled out by parents. The personal information was kept confidential to ensure the data was true and accurate.

Dental examination

The standard compliance was verified, and Kappa values were greater than 0.8. Two clinicians served as dental examiners and recorded the children's dmfs indexes. Based on the oral examination results and the definition of American Academy of Pediatric Dentist-

Table 1 Differences in parental behaviour and family state in their groups.

	Group			χ^2	*P*
	Caries-free	ECC	S-ECC		
Parents helped to brush					
Frequently	42	30	14		
Occasionally	62	76	52	12.816	0.002
Never	28	56	32		
Parents' education					
Illiteracy	1	1	2		
Primary or high school	47	61	48		
University	69	76	41	6.842*	0.033
Masters	15	24	7		
Oral health knowledge/attitudes					
Great	26	24	16		
Good	58	76	25	7.553	0.023
General	38	43	45		
Poor	10	19	12		
Family's annual income (RMB)					
< 60000	6	12	10		
60000-120000	30	58	28	8.217	0.016
120000-300000	40	32	36		
> 300000	56	60	24		
Nursing state					
Parents	110	142	82		
Grandparents	22	20	16	1.320	0.517
Total	132	162	98		

* The chi-square test' continuity correction

ry (AAPD)[1], 392 participants were divided into three groups: caries-free (n = 132), ECC group (n = 162) and S-ECC group (n = 98).

Statistical analysis

SPSS17.0 was used for statistical analysis. The results of the survey were conducted using the Kruskal-Wallis test, the chi-square test and logistic regression analysis.

Results

Description of the sample

The prevalence of deciduous caries in 392 children was 66.33% (41.33% from ECC group, 25% from S-ECC group). The dmfs was 3.33 ± 3.39 in total, of which 2.39 ± 0.96 was for the ECC group and 9.35 ± 3.07 for the S-ECC group. The children with caries were dmfs = 3, which accounted for 15.31% of all participants. In contrast, the children of dmfs = 1 and dmfs = 2 accounted for 8.67% and 13.27%. While the children of dmfs > 3 (dmfs = 9.14 ± 3.11) accounted for 29.08%.

Parents' behaviour and family situation among the three groups

Parental involvement in brushing was significantly different among the three groups ($X^2 = 12.816$, $P < 0.01$). Parents' education level, oral health knowledge and attitudes, and family annual income were significantly different among the three groups ($X^2 = 6.842$, $X^2 = 7.553$, $X^2 = 8.217$, $P < 0.05$). There was no significant difference in the nursing state among the three groups ($P > 0.05$) (Table 1).

Table 2 Differences of children oral health behaviours and dietary habits in the there groups.

	Group			χ^2	*P*
	Caries-free	ECC	S-ECC		
Frequency of sweets or sweet drinks consumption (times/d)					
≥ 2	11	18	25		
≥ 1	85	99	63	21.862	0.0001
Never	36	45	10		
Frequency of eating sweets or sweet drinks before sleeping or after brushing					
Frequently	34	52	38		
Occasionally	46	74	42	12.168	0.002
Never	52	36	18		
Age of children beginning to brush (months)					
12-24	47	30	21		
25-36	52	81	43	8.685	0.013
37-72	33	51	34		
Frequency of brushing times					
≥ 2	56	40	18		
1	38	63	43		
Not every day	22	42	34	8.201	0.017
Occasionally	16	17	3		
Birth condition					
Premature birth	4	6	2		
Low birth weight	4	2	0	4.183 *	0.382
Healthy	124	154	96		
Physical condition of the mother during pregnancy					
Healthy	126	158	96		
Malnutrition	4	4	0	1.500 *	0.472
Disease	2	0	2		
Feeding patterns					
Breast milk	66	98	62		
Mixture	51	53	26	6.410	0.171
Artificial feeding	15	11	10		

Using pacifier when sleeping					
Frequently	4	14	6		
Occasionally	46	58	34	2.089	0.352
Never	82	90	58		
Time of brushing (min)					
< 1	44	46	20		
1-3	82	104	74	3.570	0.168
≥ 3	6	12	4		
Frequency of rinsing mouth after a meal daily (times/d)					
≥ 2	29	58	30		
1	42	43	25		
Occasionally	54	45	37	3.143	0.208
Never	7	16	6		
Brushing with fluoride toothpaste					
Yes	24	34	16		
No	62	63	50		
Unknown	38	61	30	8.439 *	0.208
Unused	8	4	2		
Total	132	162	98		

* The chi-square test continuity correction

Children's oral hygiene and dietary habits in the three groups

There were significant differences in the frequency of sweets or sweet drinks consumption and eating sweets or having sweet drinks before sleeping or after brushing among the three groups ($X^2 = 21.862$, $X^2 = 12.168$, $P < 0.01$). The age of children when they started to brush and the frequency of brushing were also significantly related to ECC ($X^2 = 8.685$, $X^2 = 8.201$, $P < 0.05$). The birth case, the physical condition of the mother during pregnancy, feeding patterns, falling asleep with a pacifier, the time of brushing, the frequency of rinsing the mouth after a meal daily, and brushing with fluoride toothpaste had no significant differences among the three groups ($P > 0.05$) (Table 2).

Risk analysis

Logistic regression analysis showed that the frequency of consuming sweets or sweet drinks, the family's annual income and oral health knowledge and attitudes were risk factors for ECC. According to the regression coefficients, oral health knowledge and attitudes was the strongest, while family annual income was the weakest factor among the risk factors for ECC (Table 3).

Discussion

The results of this study showed that deciduous caries prevalence of children aged 24 to 71 months in Qingdao was 66.33% and dmfs = 3.33. This result was slightly lower than that reported by the Third National Oral

Table 3 Logistic regression analysis of factors associated with ECC.

Related factors	Regression coefficients	*P*	OR	95%CI
Frequency of sweets or sweet drinks consumption	-1.153	0.001	0.316	0.162-0.613
Family's annual income	-1.535	0.0001	0.215	0.130-0.356
Oral health knowledge and attitudes	2.298	0.0001	9.959	5.540-17.903

Health Survey in China in 2005[7]. The main reason was the different age composition in the sample. The present study is the age of 24 to 71 months, but the third national survey was aimed at five-year-olds. Additionally, different environment and lifestyle in different regions, economic level, oral education and mastery of oral knowledge, different samples selected and instruments used for examination might also contribute to these differences. Compared with the results of other cities in China, the prevalence of children's caries Qingdao is at the upper level. The overall children's deciduous caries status in China is more serious than in developed countries[8]. Therefore it is necessary to thoroughly analyse susceptible factors related to ECC.

ECC is caused by chronic deterioration of acid produced by fermentation of carbohydrate in the food by oral pathogens[9]. Our study found that the dmfs of children who consumed a lot of sweets or sweet drinks was significantly higher than children with a lower sweet or sweet drinks intake or those who did not eatsweets at all. This is a risk factor of ECC. Dawani et al[10] and Watanabe et al[11] also found that a high, frequent intake of sweets or sweet drinks can significantly increase the likelihood of ECC. Meanwhile, the high frequency of sweets or sweet drinks consumption can maintain oral pH at a low level, which will increase the risk of caries. Combined with acid produced by bacteria, it will render the tooth more susceptible to be etched by acid, thus causing caries. Also, the content, character and eating patterns of children are different from adults, and the majority of dairy products and paste foods for children have a high sugar content. These foods are highly viscous and stay on tooth surfaces for a longer time. When children sleep, salivary flow and swallowing rate decreases and oral buffering capacity decreases, which correspondingly increases the risk of caries, thus the frequency of eating sweets or sweet drinks before sleeping or after brushing also affect the formation of ECC. In this study, compared with the ECC and caries-free group, children in the S-ECC group often ate sweets or had sweet drinks before sleeping or after brushing. Therefore, to reduce the prevalence of ECC, it is essential to develop good diet habits.

Brushing teeth is the best way to remove plaque mechanically and significantly reduces the prevalence of caries. The survey found that the age at which children began to brush, the frequency of brushing, and whether parents checked children' brushing effect impacted the prevalence of ECC. Children who had not started brushing after the age of two promoted the occurrence of ECC[12]. The age at which children start oral hygiene maintenance should be sooner rather than later. When the first primary tooth erupts, parents should help children clean the oral cavity until they are able to clean their teeth for themselves. A study has shown that children who brush more than once a day have fewer caries[13,14]. In particular, children who brush their teeth every night before sleeping for more than 1 min each time[15,16] and who regularly rinse their mouths after a meal[17] have better oral hygiene maintenance than others, and their prevalence of caries is lower.

However, the study suggested that brushing time and the frequency of daily mouth rinsing after meals were not significantly different among the three groups. The reasons may lie in the small sample size of the study, in which the selected children are not typical and some children maintain a certain brushing time and constantly rinse their mouths after a meal at their parents' request, but complete the task hastily, thus not achieving the best effect.

We observed that pre-school children's self-care ability is weak, brushing quality is not good and brushing methods are sometimes not correct; moreover, due to their age and unconsciousness, their brushing behaviour is not usually regular. Therefore they cannot completely remove plaque and debris, creating a favourable con-

dition for the growth of bacteria, resulting in a high prevalence of ECC. As children's oral health behaviours are formed they often imitate their parents, whose oral health behaviours play a crucial role in the deciduous caries' prevention process[11]. Parents who pay attention to oral health, brush their teeth effectively and rinse their mouths after meals have a subtle influence on children's oral health measures. The study also found that compared with the ECC and S-ECC group, the children in the caries-free group often brushed their teeth with their parents' help and their parents' oral health knowledge and attitude were also better. Therefore, having parents with good oral health behaviour, who supervise, guide and help their children to brush their teeth timely and proactively, would be beneficial to maintain oral health and prevent caries.

In recent years, the relationships between the basic situation and the socio-economic status of a family and dental caries have received more and more attention. In the family of low socio-economic status, caries prevalence is significantly higher than in the families of high socio-economic status[18]. The investigation's conclusion also showed that with the increase of a family's annual income, ECC gradually reduced. Sakalauskienė et al[19] and Hashim et al[20] reported that parents' education, especially the mother's educational level, was associated with ECC – the higher the education, the lower the prevalence. The survey also found that parents' education in the caries-free group was higher than both the ECC group and S-ECC group. In order to know much about the difference of the parents' oral health knowledge and attidudes, we investigated whether parents brush daily, how often sweets were eaten, whether dental floss was used, whether they have regular oral examinations.

The results showed that the parents who paid close attention to oral health knowledge attached more importance to their children's and their own oral health, more actively finding, preventing and treating any problems.

This study found that there were no significant differences among the three groups with regard to nursing state, the physical condition of the mother during pregnancy, birth condition and feeding patterns and falling asleep with a pacifier. But Yokomichi et al[21] found that abnormal high birth weight was associated with increased risk of dental caries in early childhood, and Özen et al[22] found that the prolonged use at bedtime of bottles with a sweet content caused ECC; Qadri et al[23] found that compared with breast-feeding, bottle-fed children were more susceptible to ECC and that their caries were more serious. Our results differed from the others, the reason may lie in the fact that the sample size is not enough, and with the continuous improvement of living standards and medical level, birth quality control is getting better and unhealthy feeding patterns have also been improved, so the impact on ECC is more inconspicuous.

Using fluoride to prevent caries or treat early enamel caries has been recognised by most researchers[24], and the use of fluoride toothpaste is the simplest method[25,26]. However, some studies[27] did not find that using fluoride toothpaste could significantly reduce the occurrence of ECC. This study did not find that the use of fluoride toothpaste could effectively prevent caries, probably because some parents know less about fluoride toothpaste and arbitrarily choose toothpaste, or a variety of toothpastes are available on the market and there is too little fluorine in some fluoride toothpaste, or the short-term use of fluoride toothpaste for many children.

The study analysed the susceptibility factors with logistic regression. It showed that the frequency of sweets or sweet drinks consumption, a family's annual income, and oral health knowledge and attitudes were high-risk factors of ECC. However, parents' education level, the age of children beginning to brush and the frequency of brushing were not risk factors. This is probably because there are privacy issues connected with this information; some parents did not answer truthfully. Meanwhile, compared with oral health knowledge and attitudes, such as brushing quality, the influence of the age at which children begin brushing and frequency was reduced; therefore these factors were not included in the risk factors under the regression analysis.

Conclusion

Eating too many sweets, an incorrect brushing method, starting brushing in later childhood and not brushing regularly enough are all susceptible factors for ECC. Therefore, to aim at ECC risk groups, we should limit the frequency and manner of sweets consumption, use proper brushing methods, educate parents on oral health knowledge and improve people's cognition to ECC.

Conflicts of interest

The authors reported no conflicts of interest related to this study.

Author contribution

Dr Hui Bin SUN designed the survey and prepared and revised the manuscript; Dr Wei ZHANG carried out the survey, searched the literature, collected and ana-

lysed the data and prepared the manuscript; Dr Xiao Bin ZHOU collected data and carried out statistical analysis.

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