A Case-control Study Comparing 30% of Children with the Highest DMFS Score and Children with No Caries in Southern China

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Objective: *To explore the risk factors of children with a high decayed, missing and filled surfaces (DMFS) score compared with children with no caries.*
Methods: *Seven kindergartens in Conghua, located in suburban Guangzhou in Southern China, were selected. A total of 401 3- to 4-year-old children were examined for dental caries status, developmental defect of enamel (DDE) and visible plaque index (VPI). Data on children's oral health behaviour, parents' oral health knowledge, attitude and behaviour and other related information were collected by a structured questionnaire completed by their parents. A total of 120 children (30%) with the highest DMFS score (DMFS ≥ 7) and all 118 caries-free children were chosen for a case-control analysis to explore the risk factors.*
Results: *In bivariate analysis, age at start of tooth brushing, frequency of tooth brushing, frequency of sweet food consumption, pacifying children with sweet food, bottle feeding with sugary drinks, having visited a clinician, VPI, family income, parents' education level, parents' tooth brushing habit, and parents' oral health knowledge and attitude were associated with caries experience in the children. The results of logistic regression analysis showed that the factors associated with high DMFS score were VPI, frequency of sweet food consumption, family income, parents' oral health attitude and having visited a clinician.*
Conclusion: *The results of this study suggest that brushing teeth in an effective way, controlling sugar consumption and educating parents to have a more positive attitude toward oral health are important components in caries prevention among children in Southern China.*
Key words: *caries, epidemiology, risk assessment*

Chinese children have a low dental caries experience in their permanent dentition but it is high in their primary dentition. Results of the third national oral health survey in China conducted in 2005 showed that the mean decayed, missing and filled teeth (DMFT) score of 12-year-olds was 0.5 while the mean DMFT score of 5-year-olds was 3.5[1]. Control of dental caries in the primary dentition is still an important task in oral health promotion in China.

Dental caries in many populations does not follow a normal distribution. It is not uncommon that 30% of a population has more than 70% of decayed teeth, while quite a big part of the population, especially in children and young adults, are caries-free[2]. This phenomenon shows that there are children who are highly susceptible to dental caries while others are at low risk. The objectives of this study were to explore the risk factors associated with young Chinese children with high DMFS scores compared with the children with no caries, and to provide necessary information for the formulation of a dental caries prevention strategy, focusing on those

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children in the population who had the most dental caries. Differences were expected to be found through a case-control analysis.

Materials and Methods

Selection of study subjects

The study site was located at the major township (Jiekou) of Conghua County of Guangzhou in Southern China. Seven of 14 kindergartens were chosen by simple random sampling. With consent from their parents, all 401 children attending year 1 at these 7 kindergartens, aged 3 to 4 years, were recruited for this study.

Clinical examination

A community periodontal index (CPI) probe, a disposable mouth-mirror and an intra-oral LED light source were used in the dental examination. Dental caries status was firstly examined by two calibrated examiners using the criteria recommended by the World Health Organization (WHO)[3]. Children with the highest decayed, missing and filled surfaces (DMFS) score, at or above the 30th percentile, were defined as the case group, and those who were caries-free were chosen as the control group. Children in the case and the control groups were further examined for developmental defects of enamel (DDE) using the WHO criteria[3], and for visible plaque index (VPI)[4]. Four sites per tooth – disto-buccal, mid-buccal, mesio-buccal and mid-lingual surfaces – were examined. The percentage of the examined sites with visible plaque was from 0% to 100%, and it was multiplied by 100 for convenience of analysis and interpretation of the data as the score of VPI. Duplicated examinations were conducted for 10% of the study subjects to monitor the reliability between the two examiners.

Questionnaire investigation

A structured questionnaire was designed to collect information on children's oral health behaviour, parents' oral health knowledge, attitude and behaviour and other related information. The questionnaires were filled out by the parents of the children in the case and control groups.

The structured questionnaire was pre-tested before the main survey. It was given to 20 adults and necessary amendments were made according to advice from epidemiological experts to form the final questionnaire. During the major survey, 10% of the study subjects were chosen randomly to fill out the same questionnaire again 3 weeks after completing the questionnaire. Coherence of the first and second results was analysed.

Two questions on the causes and prevention of tooth decay were asked so that the dental knowledge of the parents could be measured. A dental knowledge score was constructed by counting the total number of acceptable answers given by the parents. The dental knowledge score was on an interval scale and ranged from 0 to 12, with a higher score indicating better dental knowledge. Eighteen statements concerning the importance of retaining primary teeth, tooth brushing, prevention of dental caries, dental service utilisation and dental health beliefs were designed to explore the parents' attitude toward oral health. A dental attitude score was constructed by counting the total number of statements to which the parents, in their response, showed a positive attitude. Again, this score was in an interval scale and ranged from 0 to 18, with a higher score indicating a more positive attitude.

Data analysis

SPSS 11.0 for Windows (SPSS, Chicago, IL, USA) was used in all data analysis. Chi-square test and *t* test were carried out for single factor analysis of categorical variables and continuous variables respectively. Variables showing statistical significance in the single-factor analysis were chosen as independent variables in a logistic regression analysis (forward stepwise) between the two groups. Odds ratios of the significant variables were calculated. The level of statistical significance was set at 0.05.

Results

The kappa values for the examination of caries, DDE and VPI were 0.94, 0.87 and 0.90, respectively. The results indicated that the reliability of clinical examination between the two examiners was very good. The mean DMFS score of all the 401 children examined was 6.7 ± 9.3. The top 10%, 20% and 30% of children with the highest DMFS score accounted for 43.3%, 65.7% and 79.7% of the total DMFS score respectively. The mean DMFS score of children with the highest 30% DMFS score was 16.9 ± 9.8 and the major component was 'D', which made up 99.8% of the score.

Thirty percent of the children ($n = 120$) with the highest DMFS score (7 and more) were defined as the case group and all 118 caries-free children were chosen as the control group. The mean age of the case group and the control children were both 3.6 ± 0.5 years *t* test; $P = 0.534$. In the case group, 78 were boys and 42 were

Table 1 Distribution of children in the case and control groups according to selected categorical variables (percentage)

Variable	Category	Case group (n = 120)	Control group (n = 118)	Chi-square test *P* value
Weight at birth	< 2.5 kg	3.3	3.4	0.772
	2.5–4 kg	88.3	90.7	
	> 4 kg	8.3	5.9	
Developmental defects of enamel	Yes	15.0	7.6	0.101
	No	85.0	92.4	
Mother had illness during pregnancy	Yes	9.2	12.7	0.633
	No	85.0	80.5	
	Unknown	5.8	6.8	
Tooth brushing	Yes	94.2	95.8	0.769
	No	5.8	4.2	
Age at start of tooth brushing	Before 3 years old	55.0	71.2	0.011
	3 years and older	45.0	28.8	
Frequency of tooth brushing	Once or less daily	87.5	77.1	0.042
	Twice or more daily	12.5	22.9	
Use of fluoride toothpaste	Yes	33.3	36.4	0.297
	No	20.0	26.3	
	Sometimes	23.3	22.9	
	Unknown	23.3	14.4	
Frequency of sweet food	Once or less daily	53.3	72.9	0.002
	Twice or more daily	46.7	27.1	
Pacifying children with sweet food	Yes	14.2	3.4	0.005
	No	85.8	96.6	
Method of feeding	Breast feeding	15.0	13.6	0.318
	Bottle feeding	5.0	10.2	
	Both	80.0	76.3	
Bottle feeding with sugar drinks	Yes	37.5	16.9	< 0.001
	No	62.5	83.1	
Had visited a clinician	Yes	32.5	17.8	0.011
	No	67.5	82.2	
Parents' tooth brushing habit	Once or less daily	35.8	22.9	0.033
	Twice or more daily	64.2	77.1	

Table 2 Comparison of continuous variables between children in the case and control groups

	Case group (n=120)	Control group (n=118)	*t* test
Variable	**Mean (SD)**	**Mean (SD)**	***P* value**
Visible plaque index	23.2 (13.4)	15.4 (11.4)	0.000
Age of mother	30.0 (3.4)	30.7 (3.6)	0.106
Years mother received education	11.1 (2.6)	12.1 (2.3)	0.003
Years father received education	11.7 (2.6)	12.5 (2.5)	0.020
Parents' oral health knowledge	5.0 (2.3)	5.6 (2.3)	0.037
Parents' oral health attitude	13.4 (3.3)	14.6 (2.4)	0.002
Family income (1000 RMB yuan/month)	2.3 (1.2)	3.0 (2.0)	0.002

girls, while there were 78 boys and 40 girls in the control group. There was no significant difference in the distribution of gender between the two groups (chi-square test; $P = 0.892$).

The proportion of mothers and fathers completing the questionnaire was 81.7% and 18.3%, respectively, in the case group and 80.8% and 19.2%, respectively, in the control group. There was no significant difference

Table 3 Results of logistic regression analysis for children (1 = case, 0 = control)

Variable	Beta (SE)	Odds ratio (95% CI)	*P* value
VPI	0.05 (0.01)	1.06 (1.03–1.08)	0.013
Parents' oral health attitude	-0.16 (0.06)	0.85 (0.76–0.96)	0.006
Income	-0.45 (0.14)	0.64 (0.48–0.84)	0.001
Frequency of sweet food			
Twice or more daily	0.90 (0.33)	2.46 (1.30–4.67)	0.006
Once or less daily[a]			
Had visited a dentist			
Yes	0.79 (0.36)	2.20 (1.08–4.48)	0.031
No[a]			
Constant	0.80 (0.96)		0.406

$\chi^2 = 59.274$, df = 5, $P < 0.001$; [a] reference category

between the groups (chi square test; $P = 0.721$). The percentage of coherence of the questionnaire repetitive test was 94%.

Table 1 shows the distribution of children in the case and control groups according to selected independent categorical variables. It was found that there were significant differences between the two groups with regard to the age of starting tooth brushing, frequency of tooth brushing, frequency of sweet food, pacifying children with sweet food, bottle feeding with sugar drinks, having visited a clinician and parents' tooth brushing habits. As shown in Table 2, it was found that the VPI score, number of years mother received education, parents' oral health knowledge, parents' oral health attitudes and family income were significantly different between the two groups of children.

The independent variables that were statistically significant in the bivariate analysis were entered into the logistic regression analysis. The results showed that the case group was more likely to comprise children who had a higher VPI score, more frequently ate sweet food, were from a family with lower income, had visited a clinician, and whose parents had less favourable oral health attitude scores (Table 3).

Discussion

The findings of the present study showed the level of dental caries in this group of children in Southern China was high, with a mean DMFS score of 6.7 which mostly comprised untreated decay, compared with a mean DMFS score of 4.25 in 3- to 5-year-old Chinese children found in a recent survey in two other provinces of China[5]. The third national oral health survey of China in 2005 found that the dental caries in primary teeth of 5-year-old children, mean DMFT score of 3.5, was more severe than that of children in many other countries, where a number of recent surveys found mean DMFT scores of 1.52 in England and Wales[6], 2.6 in Greece[7] and 2.18 in South Africa[8]. In the present study, the top 30% of children with the highest DMFS score accounted for 79.7% of the total DMFS score and this demonstrated the polarisation of the distribution of dental caries in Chinese children.

The analysis carried out here was influenced by the explanatory model developed by Pine et al's international collaborative research on childhood dental caries reported in 2004[9]. That international collaborative study had three models: 1) the influence of growth process of children on dental caries; 2) the influence of parental oral health attitude and behaviour on dental caries; and 3) dental caries in different economic and ethnic groups. The present study combined the first and second models, but excluded the third model, as this study was carried out in one township and the study subjects were of the same ethnicity.

In the logistic regression analysis, several factors were found to be related to children who suffered from severe caries lesions while some factors, which were statistically significant in the bivariate analysis, were not significant after taking account the influences of other factors. The oral hygiene condition of the children, measured by the VPI in this study, was found to be related to the risk of high DMFS. Parents can play an important role in cleaning of children's teeth. They should help to clean their small children's teeth and teach them until they can brush teeth well themselves. Parental supervision is also necessary to make tooth brushing an effective way to remove dental plaque in young children.

Risk factors associated with children with severe dental caries also included frequency of sweet food consumption. It is well known that sugar is an important risk factor for dental caries although its importance has been discussed again in the so-called 'post-fluoride era'[10,11].

Results of the present study indicate that limitation of sugar consumption is still an important part in the prevention of dental caries in Chinese children. However, most of the children in the present study did not use fluoride toothpaste, and other ways of topical fluoride use were uncommon. It seems that a significant proportion of young Chinese children have not received the benefit of fluoride yet. A recent study on 2-year-old children in Sweden, a developed country where fluoride toothpaste and other topical fluoride agents are widely applied, also concluded that efforts to limit and reduce sugar intake in young children are important measures for primary caries prevention[12].

The present study found that parents' oral health attitude was one of the risk indicators of children with a high DMFS score. Parents directly influence their children to form favourable oral health behaviours. In a previous study in Hong Kong, it was also reported that parents' oral health attitudes were associated with 4- to 6-year-old Chinese children's dental caries experience[13]. Similarly, parents' attitudes to diet and oral hygiene were found to be caries risk indicators of the 5-year-old children in Norway[14].

Lower family income was also found to be a risk indicator for a high DMFS score. It was reported that higher income was a protective factor for early childhood caries[15]. People who were wealthier usually had better oral health knowledge and a more positive oral health attitude[16]. They also had preferable oral health behaviours in tooth brushing and sweet food consumption[17]. Children of lower income families usually receive less attention to their oral health from their parents. This may cause the children in lower income families to be more likely to suffer from severe caries.

In the present study, having visited a clinician was found to be related to children who had a high DMFS score. It was found that most of the dental services they received were treatments, but not prevention. Previous studies in Southern China also indicated that the utilisation of dental services was 'problem-driven'[18]. Thus, it can be envisaged that those who visited a clinician were the people with more dental diseases. Professional dental service to provide prevention of caries by regular oral examination and application of caries prevention measures like the use of topical fluoride and fissure sealant is among a number of important methods for preventing caries in China. It is important to make parents more aware about prevention prior to the development of dental problems.

The results of this study suggest that children brushing their teeth in an effective way, controlling sugar consumption and educating parents to have a more positive attitude about oral health are important components in caries prevention among the children in Southern China. More attention should be paid to those who are less wealthy. A program demonstrating tooth brushing with fluoride toothpaste was very effective in the kindergartens in Southern China[19]. Implementation of these measures would probably greatly reduce the number of young children suffering from severe dental caries.

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