



The prevalence of dental erosion in preschool children in China

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KEYWORDS

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Summary Objective. To describe the prevalence of dental erosion and associated factors in preschool children in Guangxi and Hubei provinces of China.

Methods. Dental examinations were carried out on 1949 children aged 3-5 years. Measurement of erosion was confined to primary maxillary incisors. The erosion index used was based upon the 1993 UK National Survey of Children's Dental Health. The children's general information as well as social background and dietary habits were collected based on a structured questionnaire.

Results. A total of 112 children (5.7%) showed erosion on their maxillary incisors. Ninety-five (4.9%) was scored as being confined to enamel and 17 (0.9%) as erosion extending into dentine or pulp. There was a positive association between erosion and social class in terms of parental education. A significantly higher prevalence of erosion was observed in children whose parents had post-secondary education than those whose parents had secondary or lower level of education. There was also a correlation between the presence of dental erosion and intake of fruit drink from a feeding bottle or consumption of fruit drinks at bedtime.

Conclusion. Erosion is not a serious problem for dental health in Chinese preschool children. The prevalence of erosion is associated with social and dietary factors in this sample of children.

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Introduction

Dental erosion is a chemical dissolution of the dental hard tissues without bacterial involvement.¹

The underlying aetiology of erosion is believed to be a source of acid acting on a susceptible tooth. It may be caused by exposure of the teeth to frequent consumption of acidic drinks or foods, environmental exposure to acids, or reflux of gastric acid into the mouth.^{2,3} Dental erosion may progress into dentine and pulp, with consequent tooth sensitivity, altered occlusion and poor aesthetics.

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The scientific interest in dental erosion has dramatically increased during the last decade. Erosion is recognized as an important cause of loss of tooth tissue, for both adults and children and adolescents.⁴⁻¹³ Furthermore, the reduced thickness of enamel and greater acid solubility in the primary dentition contribute to higher susceptibility to erosion.^{9,10}

Previous studies of erosion, which were largely confined to European countries, were mainly either experimental investigations or case studies on a small number of reported cases. Since epidemiological data at the population level are scarce, there is a great need for prevalence studies on erosion in well-defined age groups.^{14,15} In primary teeth, prevalence surveys are few in number (Table 1), which early reported in the UK. In a study of 4-5 year olds, nearly half the children showed some erosion, with dentine exposure in 30% of primary molars.⁴ Assessment of dental erosion on general population was included in UKs 1993 National Survey of Children's Dental Health.⁵ A total of 17,061 children aged 5-15 years were examined using a modification of the Smith and Knight index.¹⁶ The survey results showed that more than half of 5-6 year olds exhibited one or more eroded primary incisors, and dentine was involved in nearly a quarter of 5-6 year old subjects. A similarly study on 1.5-4.5 year olds using the same criteria revealed that 10% of the children had erosive

lesions on the buccal and 19% of the palatal surfaces of their incisors and in 8% the dentine was affected.⁶ More recently, two studies in Saudi Arabia have shown that about one third of the children had erosion, in 12% of 2-5 year olds erosion involved dentine.^{11,12} More pronounced erosion was observed for 5-6 year olds since 34% had erosion extended into dentine or pulp.¹²

Dental erosion is thought to link with high social-economic background but it has been less considered in developing countries. China has experienced economic reform policies over more than 20 years and undergone rapid development and modernization. Modern standards of living have changed both food selection and dietary habits, but there is little or no information about dental erosion in China.

Guangxi province, the ninth largest province of China, is located in southern China, bordering Vietnam to the southwest. In 1997, the GDP of Guangxi reached RMB201 billion (~US\$25 billion), with the per capita amount being RMB4356 (~US\$544). Hubei province is located in central China, at the mid-stream of China's biggest river, the Yangtze River. It possesses an advantageous position in natural resources. The per capita GDP of RMB5899 (~US\$737) makes it amongst the more economically developed provinces.

The objective of this study was to describe the prevalence of dental erosion and possible

Table 1 Studies of the prevalence of dental erosion in primary dentition.

Authors (year)	Country	Age of subjects	Number of subjects	Prevalence of erosion
Millward et al. (1994) ⁴	UK	4-5	178	50% with erosion, over 30% with dentine involvement
O'Brien (1994) ⁵	UK	5-15	17,061	52% with erosion, 24% involved dentine
Hinds and Gregory (1995) ⁶	UK	1.5-4.5	1451	palatal surface: 19% with erosion, 8% with dentine involvement buccal surface: 10% with erosion, 2% with dentine involvement
Johes and Nunn (1995) ⁷	UK	3	135	29% had maxillary incisors affected, 17% involving both enamel and dentine
Al-Malik et al. (2001) ¹¹	Saudi Arabia	2-5	987	31% with erosion, 12% involved dentine
Al-Majed et al. (2002) ¹²	Saudi Arabia	5-6	354	34% with erosion into dentine
Harding et al. (2003) ¹³	Irish	5	202	47% with erosion, 21% affected dentine or pulp

associated factors, including social-economic status and dietary habits, in preschool children in the Guangxi and the Hubei provinces.

Materials and methods

Sample

This study was carried out in the Guangxi and Hubei provinces in China. The sample was drawn from 3 to 5-year-old children attending kindergartens both in urban and in rural areas in each province. Approval for the study was obtained from the local government and the heads of the kindergarten schools.

It was planned that approximately 1000 children would be selected in each province, of which 500 were from urban and 500 from rural areas. These numbers were chosen to allow estimation of the effect of location on dental erosion as well as providing a reasonable representation of children. The two urban cities involved in the study were the capital of each province, i.e. Nanning city of Guangxi province and Wuhan of Hubei. A multi-stage sampling technique was employed to select the kindergartens. In each city, a list of all kindergartens was firstly obtained from the local Department of Education. There were 165 kindergartens in Wuhan and 30 in Nanning. The kindergartens were then stratified according to geographic districts of the city, i.e. north, south, east and west. A total of 10 kindergartens were randomly selected in the two cities. Using class lists of the sampled kindergartens, a systematic random sampling procedure was carried out to select children after stratification by age and gender. Using these sampling methods, 950 children were selected in the urban cities of the two provinces.

A similar sampling technique was carried out to select subjects from the countryside. A total of four remote counties in the two provinces were selected and, 999 children from nine sampled kindergartens were finally chosen.

Clinical examination

Clinical examinations were conducted in the kindergartens by three examiners. The children were examined under natural light in a sitting position. Measurement of erosion was confined to primary maxillary incisors. The scoring system and criteria used was based on that used in the UK National Survey of Children's Dental Health and in Saudi Arabia.^{5,11} In this five-point ordinal scale, no evidence of tooth wear is scored 0. Tooth wear into

enamel only, such as: loss of enamel surface features giving a smooth glazed, shiny appearance; wide and shallow concavities on enamel but no dentine involved; increased translucency of the tooth due to loss of enamel thickness, etc. is coded 1. Extensive loss of enamel with dentine involvement or pulp exposure is scored 2 or 3, respectively. Code 9 is recorded when assessment cannot be made. For the purposes of the study and as in previous surveys of erosion in primary teeth,^{4-6,11} only erosion affecting palatal and/or buccal surfaces was scored as erosion, wear confined to incisal surfaces was not included.

Training and calibration of the three examiners in the use of this index were carried out by an experienced epidemiologist prior to the survey. Duplicate examinations were carried out on 30 children during the study to monitor inter-examiner variation. Reproducibility was assessed using Kappa statistic.

Questionnaire

After the clinical examination, the children's general information as well as socio-economic background and dietary habits were collected using a questionnaire translated into Chinese from its original English version.¹¹ Minor adjustments were made after tested in a pilot study. In the urban area, the questionnaire was passed to the mother of child through the kindergarten. Teaching staff ensured that forms were completed and returned. Some parents in rural countryside required help in completing the written questionnaire, so they were given an interview with standardized prompts.

The socio-economic status questions included parental occupation and education. For the purpose of this study, occupation was classified into two groups: manual workers and non-manual workers. The former included farmer, worker, private and self-employed and unemployed. The latter was composed of professor, doctor, government officer, teacher and manager. The parental education levels were classified into three groups as: (1) post-secondary, (2) secondary, and (3) primary or no formal education. Dietary information was focused on intake of drinks and fruits when they were a baby and at the time of the study.

Statistical analysis

Statistical analysis was performed using SPSS software. Chi-square test was used to assess the difference in distribution of children between groups. The difference was considered to be

statistically significant when the p value was smaller than 0.05. Multiple regression analyses were carried out to determine the factors that were independently related to presence of erosion when others were taken into account. All variables in the study were entered into a logistic model and those failing to show a significant relationship were subsequently removed in a stepwise fashion.

Results

Clinical examination was carried out on 1949 children aged 3-5 years. The distribution of the subjects by location (Hubei, Guangxi), area (rural, urban), age and gender is shown in Table 2. None of the children had gastro-intestinal problems such as gastro-oesophageal reflux, indigestion, vomiting, etc.

Prevalence of dental erosion

Results of the duplicate examination yielded the Kappa values between 0.86 and 0.88, which indicates a good inter-examiner agreement.¹⁷ A total of 112, or 5.7% of the 1949 children examined showed signs of erosion on their maxillary incisor teeth; 95 (4.9%) of which were scored as being confined to enamel, and 17 (0.9%) as erosion extending into dentine or pulp (Table 2).

A higher prevalence of erosion was found in Hubei province (6.9%) than in Guangxi province

(4.5%), and the difference was statistically significant ($p < 0.05$). The erosion prevalence for the children from urban areas was higher than that from rural areas (6.8 vs. 4.7%), but the difference was not quite significant ($p = 0.05$). Neither prevalence nor severity of erosion was significantly related to age or gender ($p > 0.05$).

Erosion and social factors

Eighty-three percent of the children who had been clinically examined returned the questionnaires. Table 3 shows the prevalence of erosion in relation to social class based on parental occupation and education levels. Since there were few parents with education limited to primary school or no education, the numbers in this group were very small and were then grouped with secondary school as 'low education'. There was no significant difference in erosion prevalence in relation to the parental occupation and education between the two provinces and the results were pooled.

In relation to the parents' occupation, a higher prevalence of erosion was seen in those children whose parents were from non-manual group; but the difference between the two occupational groups was not statistically significant ($p > 0.05$).

Prevalence of erosion in relation to parents' education suggested that there was statistically significant difference between high education and low education. Sixty-three (7.4%) of the children whose fathers were educated to college

Table 2 Prevalence and severity of erosion in relation to age, gender, and location of children.

	No. of children	No. (%) of children			
		With no erosion	With any erosion	With erosion confined to enamel	With erosion in dentine or pulp
<i>Province*</i>					
Guangxi	956	913 (95.5)	43 (4.5)	34 (3.6)	9 (0.9)
Hubei	993	924 (93.1)	69 (6.9)	61 (6.1)	8 (0.8)
<i>Area</i>					
Urban	950	885 (93.2)	65 (6.8)	60 (6.3)	5 (0.5)
Rural	999	952 (95.3)	47 (4.7)	35 (3.5)	12 (1.2)
<i>Age</i>					
3 years	373	353 (94.6)	20 (5.4)	17 (4.6)	3 (0.8)
4 years	801	758 (94.6)	43 (5.4)	35 (4.4)	8 (1.0)
5 years	775	726 (93.7)	49 (6.3)	43 (5.5)	6 (0.8)
<i>Gender</i>					
Male	1028	972 (94.6)	56 (5.4)	45 (4.4)	11 (1.1)
Female	921	865 (93.9)	56 (6.1)	50 (5.4)	6 (0.7)
Total	1949	1837(94.3)	112 (5.7)	95 (4.9)	17 (0.9)

* $p < 0.05$, Chi-square test.

Table 3 Prevalence of erosion in relation to social class based on parental occupation and education.

	Erosion	
	No. of children	%
<i>Father's occupation</i>		
Manual	54	5.4
Non manual	37	6.5
<i>Mother's occupation</i>		
Manual	58	5.2
Non manual	33	6.6
<i>Father's education*</i>		
High education (post-secondary)	63	7.4
Low education (secondary or below)	28	3.7
<i>Mother's education**</i>		
High education (post-secondary)	49	7.2
Low education (secondary or below)	42	4.7

* $p < 0.01$, Chi-square test. ** $p < 0.05$, Chi-square test.

or post-graduate level had erosion. The erosion prevalence of this high-education group was twice that of low-education group ($p < 0.01$). Similarly, there was a significant higher prevalence of erosion for children whose mothers had high education ($p < 0.05$).

Erosion and dietary habit

There were differences in erosion prevalence in relation to consumption of fruit drinks. The prevalence of erosion among children who had been given fruit juice or fruit syrup in a feeding bottle when the child was a baby was 9.3%, compared to 4.6% among those who had not had such drinks (Table 4). The difference was statistically significant ($p < 0.01$). Table 5 showed the presence of erosion in relation to bedtime fruit drinks given in a bottle as a baby; similarly,

Table 4 Prevalence of erosion in relation to taking fruit drinks when the child was a baby.

		Erosion		
		Present	Absent	Total
Fruit juice/ syrup from feeding bottle	Yes	32	311	343
	No	59	1219	1278
	Total	91	1530	1621

$p < 0.01$, Chi-square test.

Table 5 Prevalence of erosion in relation to taking fruit drinks at bedtime when the child was a baby.

		Erosion		
		Present	Absent	Total
Fruit juice/ syrup from feeding bottle at bedtime	Yes	21	205	226
	No	70	1325	1395
	Total	91	1530	1621

$p < 0.05$, Chi-square test.

a significant relationship was observed (9.3 vs. 5.0%, $p < 0.05$).

Among drinks given at bedtime nowadays, i.e. herbal tea, fruit juice/syrup, fizzy drinks, etc. the highest prevalence of erosion (11.5%) was seen in children who consumed fruit juice or syrup although there were too few children in each drink group to justify statistical analysis. There appeared to be little difference in the prevalence of erosion in relation to specific fruits, including orange, apple and grape.

Multiple regression analysis

Table 6 displays the regression model predicting the presence of dental erosion. When other variables were taken into account, the education level of the father and having fruit drinks from feeding bottle as a baby had a significant independent effect on dental erosion. The children whose fathers had been educated to high level (post-secondary school) were twice as likely to have erosion as those whose fathers had low education (secondary school or below) (OR = 2.003). Children having fruit juice or syrup as a baby were also twice likely to have erosion than children not having this drink (OR = 2.006).

Discussion

The present study was a pathfinder epidemiological survey on dental erosion carried out in China. In order that the findings could be comparable with those of previous studies, similar scoring system was used for measurement of erosion. There may be some bias in the questionnaire results due to the two different methods of administration, i.e. self-completion vs. interview, in the urban and the rural areas. The questionnaire was pilot tested in parents from urban areas and the result showed that there were no problems for them to complete the questionnaire by themselves. However, when

Table 6 Results of logistic regression for erosion. Regression coefficient (*B*), standard error (*SE*), significance (*P*), odds ratio (*OR*) with 95% CI for *OR*.

Variables	<i>B</i>	<i>SE</i>	<i>P</i>	<i>OR</i>	95% CI for <i>OR</i>	
					Lower	Upper
Father's education (high/low)	0.695	0.230	0.003	2.003	1.276	3.144
Fruit juice/syrup from bottle as a baby (having/not having)	0.696	0.234	0.003	2.006	1.268	3.173

the parents in the rural countryside were asked to complete the written questionnaire, they came across problems in understanding and answering the questions. Thus, an interview with standardized prompts was provided to the parents in rural settings by an interviewer who was independent of clinical examination.

The striking prevalence data for dental erosion in primary teeth reported in UK,^{4,5} where around half of the children exhibited signs of erosion, was not found for Chinese children in the present study. The prevalence of approximately 6% among these Chinese young children was also lower than the 47% reported in Ireland and 31% in Saudi Arabia.^{11,13}

In China, the consumption of soft drinks has increased markedly recent years, along with a rise in the average levels of consumer spending. Many soft drink brands contend with one another in the growing Chinese market, and many Chinese have become used to having soft drinks each day, although the per capita soft drinks consumption of 8 l/year (http://www.mindbranch.com/catalog/print_product_page.jsp?code=R300-0090) is relatively low compared with many developed countries. For example, the consumption of soft drinks and fruit juice in England in 2000 amounted to over 120 l per capita per year.¹⁸ In Germany, the intake of soft drinks and fruit juice reached 91 and 40 l per capita, respectively.¹⁹ Despite the low prevalence of erosion reported in this study, significant difference was observed between the locations. Children from a province more economically developed had a higher prevalence of erosion. In addition, children from urban cities were more affected than those from rural areas.

Indicators of social class for the present study included parental occupation and education status. Significant positive correlation was observed for the latter, i.e. the higher education level of the parents, the higher erosion prevalence in the children. Previous studies had inconsistent findings on the relationship between erosion and social factors.^{4-6,11,13} Our results are in agreement with those reported by Millward and co-workers, who studied the influence of socio-economic

background on the prevalence of erosion, and found children from the low socio-economic groups having less erosion.⁴ Other workers have found an inverse relationship, i.e. as social deprivation worsened the presence of dental erosion increased.^{5,6,13} Some reported no relationship between erosion and social class.¹¹

The correlation between social class and the presence of erosion found in the present study may be partially attributed to the education status having an influence on the family's life styles and value systems. For those parents who had high-education level, they might have adopted a more Western style diet to feed their children, such as consumption of fruit juice, carbonated soft drinks and some new type of drinks, etc.; while those with low-education level may prefer to continue the use of traditional drinks such as herbal tea for their children.

The dietary information relating to dental erosion was evaluated using a questionnaire to parents. Consumption of soft drinks was still uncommon and infrequent amongst Chinese children. However, intake of fruit juice or syrup from a feeding bottle at babyhood showed a significant relationship to presence of erosion. There was also a correlation between erosion and the consumption of fruit drinks at bedtime as a baby. The association between acidic food and beverages and dental erosion is well established in the literature.²⁰⁻²⁴ On the other hand, individual modifying factors need to be taken into account, such as quantity and composition of saliva, tooth composition and structure, dietary patterns, oral hygiene practice, and medical conditions.^{9,14,25,26}

Results of regression analysis show having fruit juice as a baby and the education level of child's father to be independent erosion risk indicators; also both were significantly related to erosion in single-variate analysis. In conclusion, the prevalence of erosion is associated with social and dietary factors in this sample of children, but that is not a serious problem for the general dental health of preschool children in China at present.

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References

1. Pindborg J. In: *Pathology of dental hard tissues*. Copenhagen: Munksgaard; 1970.
2. Scheutzel P. Etiology of dental erosion—intrinsic factors. *European Journal of Oral Sciences* 1996;**104**:178-90.
3. Zero DT. Etiology of dental erosion—extrinsic factors. *European Journal of Oral Sciences* 1996;**104**:162-77.
4. Millward A, Shaw L, Smith A. Dental erosion in four year-old children from differing socioeconomic backgrounds. *Journal of Dentistry for Children* 1994;**61**:263-6.
5. O'Brien M. Children's dental health in the United Kingdom 1993. *Office of population censuses and surveys*. London: HMSO; 1994.
6. Hinds K, Gregory J. National Diet and Nutrition survey: children aged 1(1/2) to 4(1/2) years. *Office of population censuses and surveys*. London: HMSO; 1995.
7. Jones SG, Nunn JH. The dental health of 3-year-old children in east Cumbria 1993. *Community Dental Health* 1995;**12**: 161-6.
8. Lazarchik DA, Filler SJ. Effects of gastroesophageal reflux on the oral cavity. *American Journal of Medicine* 1997;**103**: 107S-113S.
9. Shaw L, Weatherill S, Smith A. Tooth wear in children: an investigation of etiological factors in children with cerebral palsy and gastroesophageal reflux. *Journal of Dentistry for Children* 1998;**65**:484-6.
10. Harley K. Tooth wear in the child and the youth. *British Dental Journal* 1999;**186**:492-6.
11. Malik MI, Holt RD, Bedi R. The relationship between erosion, caries and rampant caries and dietary habits in preschool children in Saudi Arabia. *International Journal of Paediatric Dentistry* 2001;**11**:430-9.
12. Al-Majed I, Maguire A, Murray JJ. Risk factors for dental erosion in 5-6 year old and 12-14 year old boys in Saudi Arabia. *Community Dentistry and Oral Epidemiology* 2002;**30**:38-46.
13. Harding MA, Whelton H, O'Mullane DM, Cronin M. Dental erosion in 5-year-old Irish school children and associated factors: a pilot study. *Community Dental Health* 2003;**20**: 165-70.
14. Nunn JH. Prevalence of dental erosion and the implications for oral health. *European Journal of Oral Sciences* 1996;**104**: 156-61.
15. ten Cate JM, Imfeld T. Dental erosion, summary. *European Journal of Oral Sciences* 1996;**104**:241-4.
16. Smith BG, Knight JK. An index for measuring the wear of teeth. *British Dental Journal* 1984;**156**:435-8.
17. World Health Organization. *Oral health surveys, basic methods*. 4th ed. Geneva: World Health Organization; 1997.
18. Lussi A, Jaeggi T, Schaffner M. Diet and dental erosion. *Nutrition* 2002;**18**:780-1.
19. Ganss C, Klimek J, Giese K. Dental erosion in children and adolescents—a cross-sectional and longitudinal investigation using study models. *Community Dentistry and Oral Epidemiology* 2001;**29**:264-71.
20. Asher C, Read MJ. Early enamel erosion in children associated with the excessive consumption of citric acid. *British Dental Journal* 1987;**162**:384-7.
21. Jarvinen VK, Rytomaa II, Heinonen OP. Risk factors in dental erosion. *Journal of Dental Research* 1991;**70**:942-7.
22. Larsen MJ, Nyvad B. Enamel erosion by some soft drinks and orange juices relative to their pH, buffering effect and contents of calcium phosphate. *Caries Research* 1999;**33**: 81-7.
23. Lussi A, Schaffner M. Progression of and risk factors for dental erosion and wedge-shaped defects over a 6-year period. *Caries Research* 2000;**34**:182-7.
24. Meurman JH, Harkonen M, Naveri H, Koskinen J, Torkko H, Rytomaa I, et al. Experimental sports drinks with minimal dental erosion effect. *Scandinavian Journal of Dental Research* 1990;**98**:120-8.
25. Johansson AK, Lingstrom P, Birkhed D. Comparison of factors potentially related to the occurrence of dental erosion in high- and low-erosion groups. *European Journal of Oral Sciences* 2002;**110**:204-11.
26. Moss SJ. Dental erosion. *International Dental Journal* 1998;**48**:529-39.

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