

## Epidemiology Study of Dental Fluorosis in China

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China

**SUMMARY:** The Epidemiology of dental fluorosis in China is studied using the cross-sectional national oral health survey from 1995. 46,904 school children from 11 different provinces, aged 12 and 15 years, are selected randomly by stratification and multistage clustering. Urban-rural and male-female samples are balanced and the modified Dean's index, CFI, is estimated.

It is found the dental fluorosis prevails in all surveyed provinces. However, the majority of the study subjects had the very mild and mild fluorosis. Of the affected subjects about 62 % had the very mild or mild scores and 38 % had the moderate or severe scores.

The prevalence varies to a large extent among the different provinces. Tientsin has prevalence 16.2 times higher than the average prevalence in the 10 other provinces; 49.6 % and 2.6 % respectively. The CFI is 18.5 times higher in Tientsin than in the 10 other provinces; 0.06 and 1.25 respectively. Rural Tientsin has a prevalence as high as 78 %.

The urban-rural differences do not seem to have a general trend. Both in Shanghai and in Guangdong dental fluorosis is slightly higher in urban than in rural areas. However, in 6 of the other 9 provinces, i.e. Beijing, Tientsin, Shandong, Liaoning, Zhejiang and Hubei, fluorosis prevails much more in the rural areas.

The study indicates that dental fluorosis in China is mainly due to excess of fluoride in the drinking water.

**Key words:** Epidemiology study, fluorosis, dental fluorosis, Deans index, community fluorosis index, CFI, China, China province, Tientsin province, drinking water.

### INTRODUCTION

**Dental fluorosis:** Fluorosis is a kind of enamel hypoplasia caused by intake of excessive fluoride during the period of the enamel maturing. The mechanism is a destruction of the ameloblasts and the production of abnormal mottled enamel 1. The appearance of the damaged enamel would differ depending on the severity and timing of the exposure to fluoride. Endemic fluorotic areas, where excessive fluoride occurs in the environment, are found all over the world. In most cases the endemic fluorosis is due to too high fluoride concentrations in the drinking water. Another type of fluorosis is found in areas where intensive coal burning takes place.

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**Fluoridation and fluorosis:** Meanwhile, with the confirmation of the caries preventive effect of fluoride, all countries started using fluoridated toothpaste and some countries even began to fluoridate drinking. Many studies had showed that the prevalence of caries had declined obviously 1-3. But at the same time, the prevalence of fluorosis in many countries had a trend to increase 4-5, whereas, some studies also concluded that the fluorosis prevalence remained the same 6.

**Fluorosis in China:** The first national oral health survey in China was carried out in 1983, organized by the ministry of health and the ministry of education. 383,265 students from 29 provinces were sampled and their oral health status was evaluated. The subjects were grouped according to age: 7, 9, 12, 15 and 17. The prevalence of the fluorosis varied from 0 to 69.5 % 8.

Chinese data on endemic fluorosis from 1990 to 2000 indicate that the state of the fluorosis had been well under control during these ten years. The prevalence of water-based fluorosis in Huabei, Huadong and Xibei was declining, while the prevalence of fluorosis in Dongbei was increasing. Also the non-water-based fluorosis is reported to have been rising in west of our country 7.

In 1995, a second national oral health survey was conducted by the Center of Diseases Control, Ministry of Health and the National Committee for Oral Health. Now a third oral health survey is in its planning phase, to be carried out probably in 2005.

The present cross-sectional study investigates the fluorosis prevalence in China, the date being withdrawn from the 1995 survey.

## MATERIALS AND METHODS

**Sampling:** The random stratified multistage and clustering sampling methods were used. The oral health status varies among different age, sex and residential area. Thus in the sampling, the number of male (23,452) and female (23,452) were balanced, but the samples in the urban areas was double of that in rural ones. In China, the proportion of population in urban to rural areas was 37.7 % to 62.3 %. All subjects were local residents who have been living in the locality since they were 6 years old.

Altogether 23,452 students aged 12 years old and 23,452 15-year-old students were selected from eleven provinces all over the China. In each province, we selected three typical cities, one was the capital city, another was a local city (a kind of middle city) and a third was a county city (a kind of small city). In every city, one urban area and one rural area were selected.

**Clinical investigation:** Before the national oral health survey was carried out, the National Committee for Oral Health allotted the work to the local Committee for Oral Health from 11 provinces. A technical instruction team was constituted in each province to take charge of the organization, sampling and training. The leaders of the teams were all experienced dentists. The modified Dean's Index of fluorosis was used. Only a score was obtained from each person, based on the lower of the two most severely affected teeth. The classification is shown in Table 1.

Classification & Weighting	Diagnostic Criteria
Normal ~0	The enamel presents the usual translucent semi-vitreous type of structure. The surface is smooth, glossy, and usually of a pale creamy white colour.
Questionable~ 0.5	The enamel discloses slight aberrations from the translucency of normal enamel, ranging from a few white flecks to occasional white spots. This classification is utilized in those instances where a definite diagnosis of the mildest form of fluorosis is not warranted and a classification of "normal" not justified.
Very mild ~ 1	Small, opaque, paper-white areas scattered irregularly over the tooth but not involving as much as approximately 25 % of the tooth surface. Frequently included in this classification are teeth showing no more than about 1-2 mm of white opacity at the tips of the summits of the cusps of the bicuspid or second molars.
Mild ~ 2	The white opaque areas in the enamel of the teeth are more extensive but do not involve as much as 50 % of the tooth.
Moderate ~ 3	All enamel surfaces of the teeth are affected, and surfaces subject to attrition show marked wear. Brown stain is frequently a disfiguring feature.
Severe ~ 4	All enamel surfaces are affected and hypoplasia is so marked that the general form of the tooth may be affected. The major diagnostic sign of this classification is the discrete or confluent pitting. Brown stains are widespread, and teeth often present a corroded-like appearance.
CFI = $0.5 * \text{number of people of "questionable"} + 1 * \text{number of "very mild"} + 2 * \text{number of "mild"} + 3 * \text{number of "moderate"} + 4 * \text{number of "severe"}$ / the number of people examined	

Nature light was used to examine and the teeth were not dried before the examination. The number of examiners in each province was not more than ten to lessen the bias between examiners.

## RESULTS

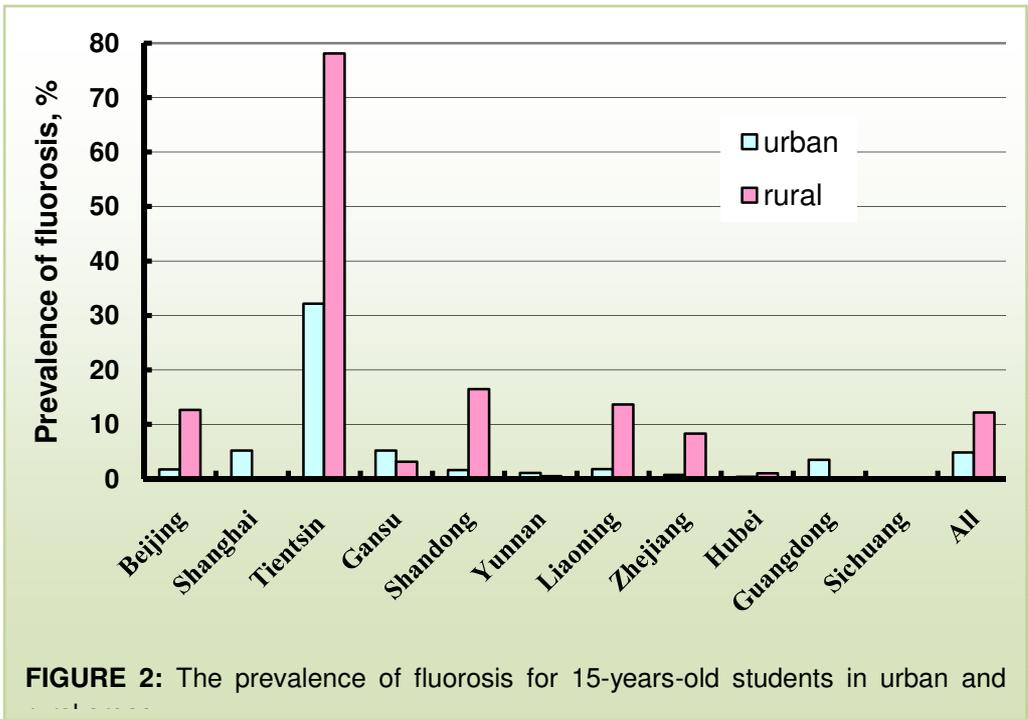
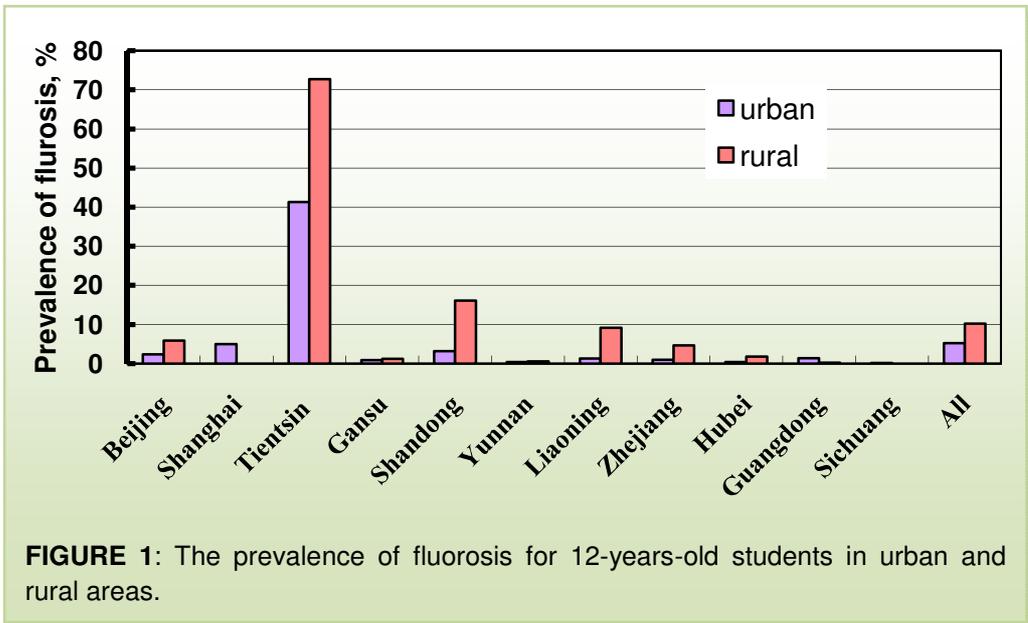
The data obtained are summarised in Table 1 and 2. Figures 1 & 2 illustrate the fluorosis prevalence and the urban/rural differences in the provinces. Figures 3 & 4 illustrate the Community Fluorosis Index and the 12/15 years-group differences in the provinces. Figures 5 & 6 illustrate the distribution of fluorosis severity among the selected age groups in surveyed provinces all together.

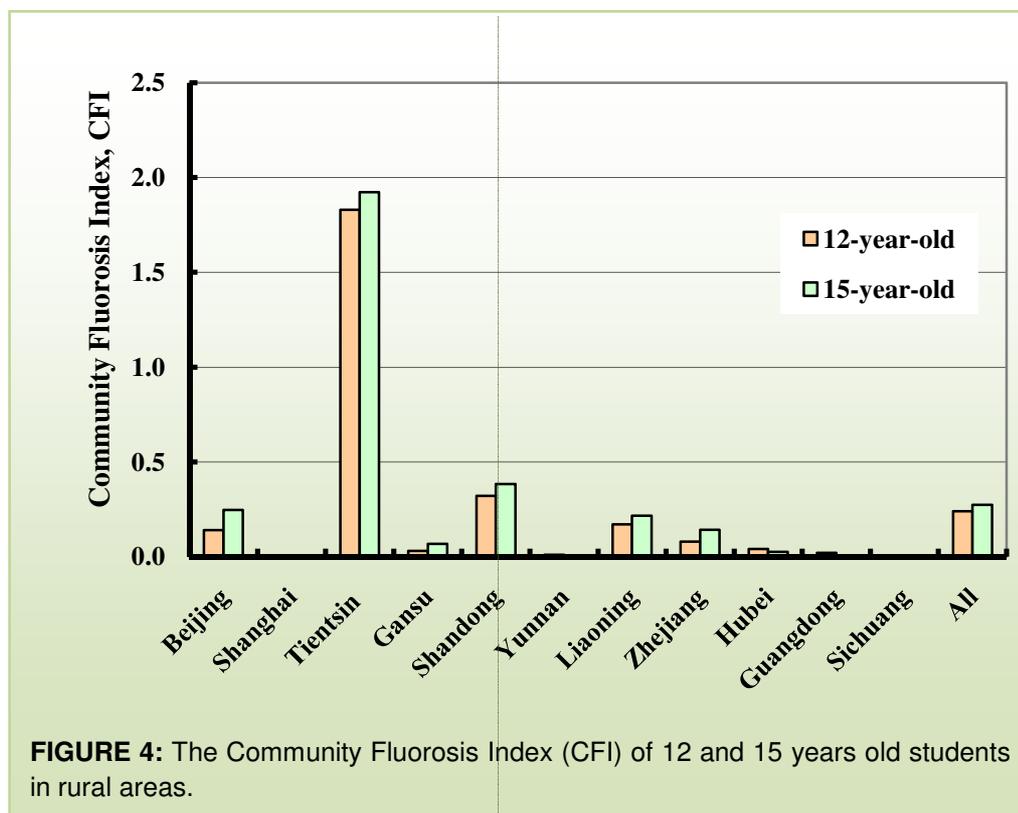
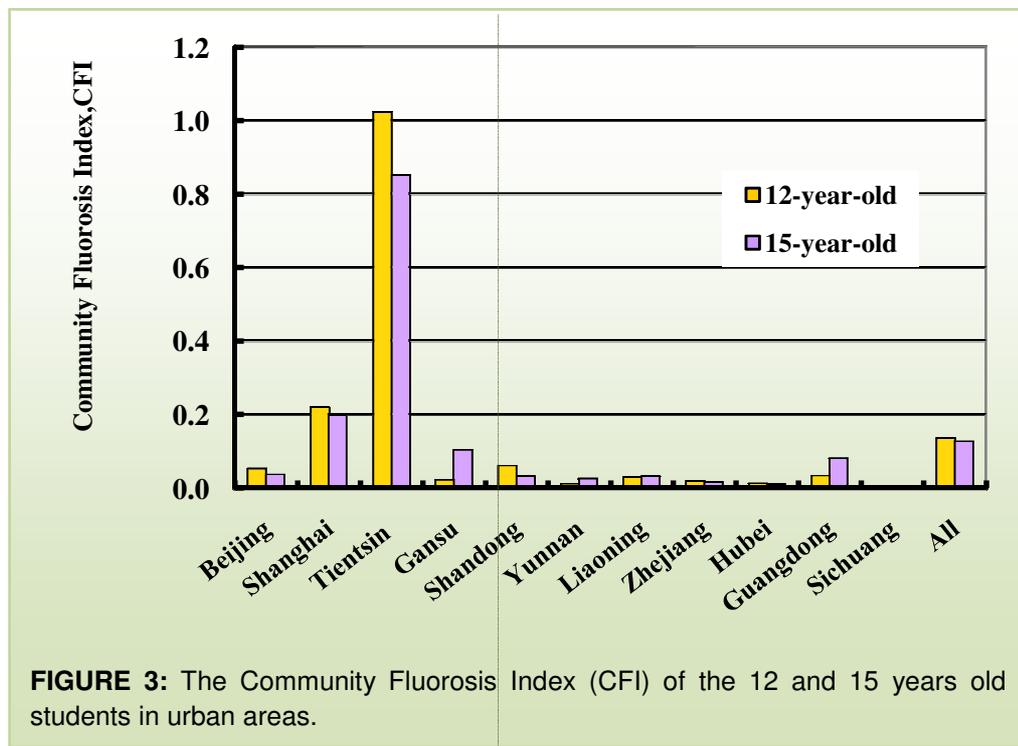
**TABLE 1:** The prevalence of fluorosis of 12 and 15 years old students in urban and rural areas of the surveyed provinces.

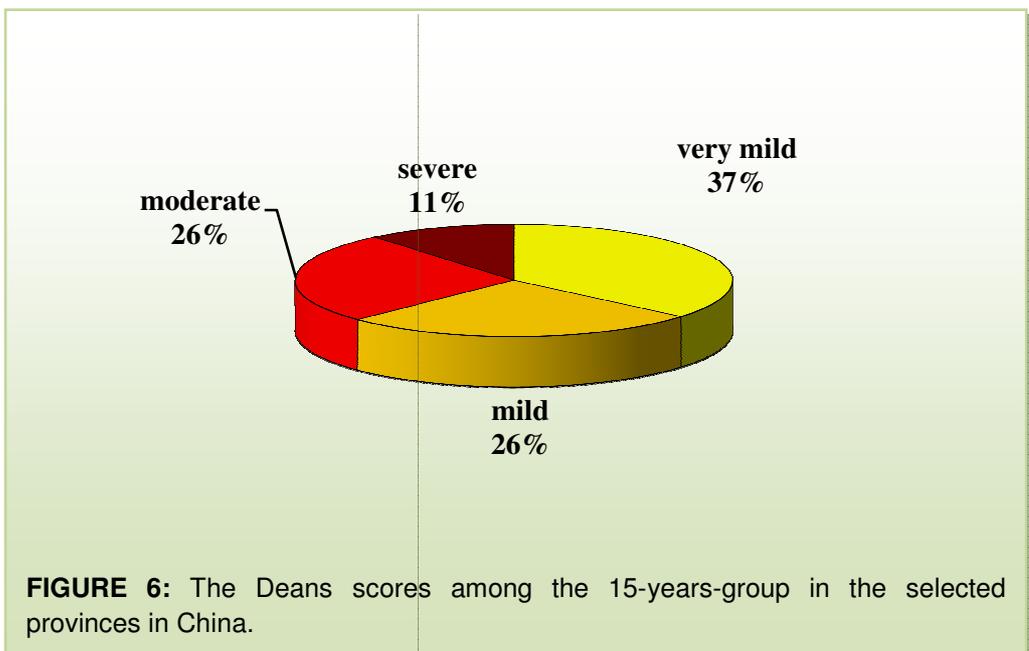
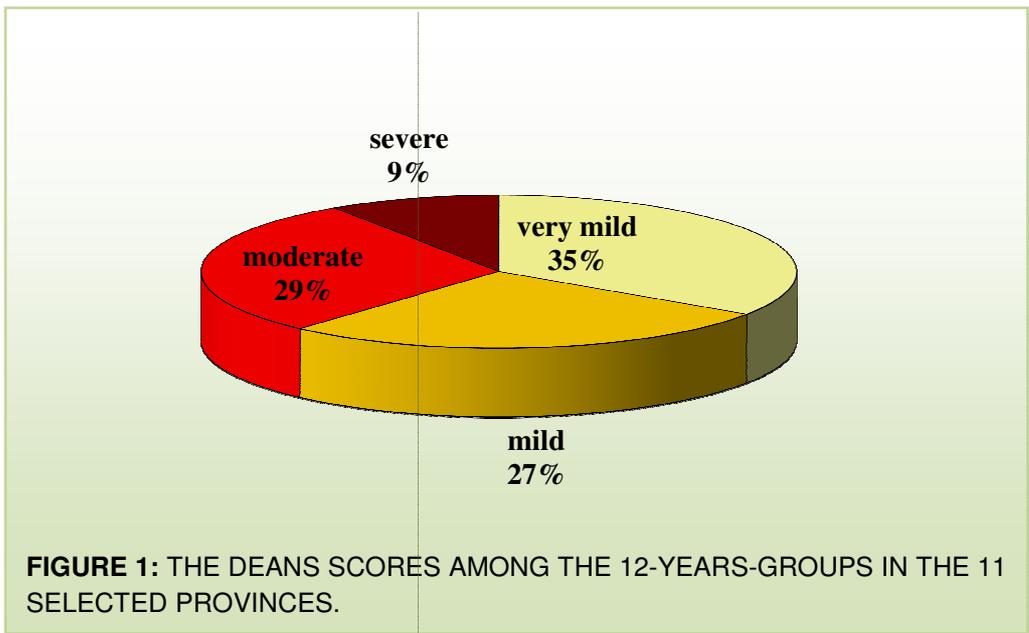
Province	12-year-old			15-year-old		
	Urban	Rural	Both	Urban	Rural	Both
Beijing	2.39	5.90	3.56	1.69	12.64	5.35
Shanghai	5.00	0.00	3.33	5.14	0.00	3.42
Tientsin	41.31	72.75	51.69	32.11	78.09	47.47
Gansu	0.92	1.26	1.03	5.14	3.09	4.46
Shandong	3.17	16.15	7.50	1.55	16.43	6.52
Yunnan	0.42	0.56	0.47	1.06	0.42	0.84
Liaoning	1.34	9.13	3.94	1.76	13.62	5.72
Zhejiang	0.99	4.63	2.20	0.7	8.29	3.24
Hubei	0.42	1.83	0.89	0.35	0.98	0.56
Guangdong	1.41	0.28	1.03	3.45	0.14	3.35
Sichuang	0.14	0.00	0.09	0.00	0.00	0.00
All	5.21	10.23	6.89	4.81	12.16	7.27

**TABLE 2:** The Community Fluorosis Index (CFI) of the 12 and 15 years old students in the surveyed provinces.

Province	12-year-old			15-year-old		
	Urban	Rural	Both	Urban	Rural	Both
Beijing	0.051	0.140	0.081	0.035	0.247	0.106
Shanghai	0.218	0.000	0.146	0.197	0.000	0.131
Tientsin	1.022	1.830	1.292	0.851	1.923	1.209
Gansu	0.021	0.030	0.024	0.102	0.067	0.090
Shandong	0.059	0.320	0.147	0.030	0.383	0.148
Yunnan	0.010	0.010	0.011	0.024	0.006	0.018
Liaoning	0.028	0.170	0.076	0.030	0.216	0.092
Zhejiang	0.017	0.080	0.038	0.014	0.142	0.057
Hubei	0.011	0.040	0.019	0.008	0.025	0.014
Guangdong	0.032	0.020	0.027	0.079	0.007	0.055
Sichuang	0.004	0.000	0.003	0.000	0.000	0.000
All	0.134	0.240	0.169	0.125	0.274	0.175







## DISCUSSION

**Background studies:** Many investigations showed that the prevalence of fluorosis was quite associated with the fluoride concentration in drinking water, and the prevalence is directly related to water fluoride concentration<sup>10-11</sup>. Also some studies showed that the prevalence is increasing with the increased water fluoride concentration<sup>12</sup>. A Chinese survey concluded that the relation between the prevalence of fluorosis and the water fluoride concentration appeared is a linear one<sup>13</sup>.

**Province differences:** In China 37.7 % of the 1.3 billion population (2002) live in urban areas, while 62.3 % in rural areas. In most urban areas, portable water is made easily available, while well water is the most common source in rural areas. The quality of the portable water is checked up strictly checked, including the fluoride concentration, while well water is often pumped from the deep underground without further control.

This study shows that the dental fluorosis occurs in all 11 surveyed provinces of China. However, the prevalence in Tientsin City appears to be about 16.2 times the prevalence in the 10 other provinces; 49.6 % and 2.6 % respectively. The Deans score is 18.5 times higher in Tientsin than in the 10 other provinces, 0.06 and 1.25 respectively.

This is in agreement with that the fluoride concentration in water sampled in Tientsin varied from 0.5 mg/L to 5 mg/L, while the water fluoride concentrations in other sampling sites were all less than 1 mg/L. Thus Tientsin is a typical fluorotic area, where the fluorosis is related to the drinking water. It constitutes a severe public health problem.

**Urban-rural differences:** The urban-rural differences do not seem to have a general trend. Both in Shanghai and in Guangdong dental fluorosis is slightly higher in urban than in rural areas. However in 6 of the other 9 provinces, i.e. Beijing, Tientsin, Shandong, Liaoning, Zhejiang and Hubei, fluorosis prevails much more in the rural areas. Probably these differences are similarly associated with the fluoride concentration in water.

**Fluorosis severity distribution:** Figures 5 & 6 show that the majority of the study students had the very mild and mild fluorosis. Of the affected subjects about 62 % had the very mild or mild scores and 38 % had the moderate or severe scores. This is similar to findings of severity distribution as found by Rozier 1999<sup>14</sup> in North American areas, by Riordan & Banks in western Australia, and by Clark et al. in Canadian areas<sup>16-18</sup>.

**Age differences:** This study involves only 12 years and 19 years groups. No significant difference could be found between these groups in our survey. This is probably reflecting that the exposure to fluoride has been of the magnitude during the

actual 7 years of China's otherwise very long history and changes in environments and social habits.

### **ACKNOWLEDGMENTS**

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### **REFERENCES**

1. World Health Organization. Prevention methods and programmes for oral diseases. Report of a WHO Expert Committee. WHO technical report series 713. Geneva, 1984.
2. Ismail AI, Brodeur JM, Kavanagh M, Boisclair G, Tessier C, Picotte L. Prevalence of dental caries and dental fluorosis in students, 11-17 years of age, in fluoridated and nonfluoridated cities in Quebec. *Caries Res* 1990;24:290-7.
3. McKnight CB, Levy SM, Cooper SE, Jakobsen JR, Warren JJ. A pilot study of dental students' esthetic perceptions of computer-generated mild dental fluorosis compared to other conditions. *J Public Health Dent* 1999;59(1):18-23.
4. Pendrys DG, Stamm JW. Relationship of total fluoride intake to beneficial effects and enamel fluorosis. *J Dent Res* 1990;69(Spec Iss):529-538.
5. Clark DC. Trends in the prevalence of dental fluorosis in North America. *Community Dent Oral Epidemiol* 1994;22:148-152.
6. Heifetz SB, Driscoll WS, Horowitz HS, et al. Prevalence of dental caries and dental fluorosis in areas with optimal and above-optimal water fluoride concentrations: a 5-year follow up survey. *Jam Dent Assoc*, 1988;116(4):490-5.
7. Sun DJ, Shen YF, Zhao XH, et al. Analysis on the disease trend and present state of endemic fluorosis in China mainland. *Chinese J Endem* 2001;20(6):429-33.
8. Health Ministry, People's Republic of China. Epidemiology study of caries and periodontal diseases of students in China. 1<sup>st</sup> ed. Beijing: 1987.
9. Dean HT. Classification of mottled enamel diagnosis. *J Am Dent Assoc* 1934;21:1421-1426.
10. Segreto VA, Camann D, Collins EM, Smith CT. A current study of mottled enamel in Texas. *J Am Dent Assoc* 1984;108:56-59.
11. Warren JJ, Levy SM, Kanellis MJ. Prevalence of dental fluorosis in the primary dentition. 2001;61(2):87-91.
12. Evans RW. Changes in dental fluorosis following an adjustment to the fluoride concentration of Hong Kong's water supplies. *Adv Dent Res* 1989;3:154-160.
13. Wang XC, Guo XJ, Kawahara K, et al. A study on the correlative relation between fluoride exposure of groundwater and endemic fluorosis. *Chinese J Endem* 2001;20(6):434-37.
14. Rozier RG. The prevalence and severity of enamel fluorosis in North American children. *J Public Health Dent* 1999 Fall;59(4):239-46.
15. Riordan PJ, Banks J. Dental fluorosis and fluoride exposure in Western Australia. *J Dent Res* 1991;70:1022-1028.

16. Clark DC, Hann HJ, Williamson MF, Berkowitz J. Aesthetic concerns of children and parents in relation to different classifications of the Tooth Surface Index of Fluorosis. *Community Dent Oral Epidemiol* 1993;21:360-4.
17. Clark DC, Hann HJ, Williamson MF, Berkowitz J. Aesthetic concerns of children and parents in relation to different classifications of the Tooth Surface Index of Fluorosis. *Community Dent Oral Epidemiol.* 1994;22(6):461-4.
18. Clarke JHC, Mann JE. Natural fluoridation and mottling of teeth in Lincolnshire. *Br Dent J* 1960;108(5):181-187.