Letter to the Editor

Prevalence of Brick Tea-type Fluorosis in Children Aged 8–12 Years in Qinghai Province, China*

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Fluorosis is a serious health problem, and an endemic disease in certain areas in China, India, and some countries in Africa[1]. There are three types of fluorosis which includes drinking-water type fluorosis, coal-burning pollution type fluorosis, and brick tea-type fluorosis. Coal-burning pollution type fluorosis and brick tea-type fluorosis are found only in mainland China mainland. Dental fluorosis (DF) is an obvious external sign of excessive early childhood consumption of fluoride, while skeletal fluorosis (SF) becomes crippling, usually occurs between 30 and 50 years of age in endemic regions[2]. Brick tea-type fluorosis is a specific type that is caused by consumption of fluoride-containing brick tea, which is distributed in the southern and western parts of China including Qinghai, Tibet, Xinjiang, Sichuan, and Inner Mongolia[3].

Brick tea reportedly promotes resistance to cold, and aids digestion, thus it is considered as one of life's necessities by Tibetan and other minority nationalities in western China[4]. Brick tea-type fluorosis was discovered in the 1980s. Systematic research investigating its epidemiological characteristics and associated patterns commenced in 1999[2]. To date, the prevalence of brick tea-type fluorosis in schoolchildren in western China has not been thoroughly investigated.

The current prevalence of brick tea-type fluorosis in Qinghai Province in China is uncertain, and in the Yushu region of Qinghai Province no detailed investigations in this regard have ever been conducted. The main aim of the current study was to determine the prevalence of DF in schoolchildren aged 8–12 years in Qinghai Province, China, with particular focus on the Yushu region.

The present study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. It was approved by the Ethics Committee of the Qinghai Institute for Endemic Disease Prevention and Control, located in China. Written informed consent was provided by the parent or legal guardian of every child included in the study for their participation.

Three regions were included in the present study, Yushu Prefecture (including Yushu City, Qumalai, Zhiduo, Chenduo, Zaduo, and Nangqian 5 counties), Hainan Prefecture (including Gonghe, Guide, Xinghai, Guinan, and Tongde 5 counties), and Haidong City (including Piangan, Ledu, Xunhua, Minghe, Hualong, and Huzhu 5 counties). All counties and cities in all three of the regions investigated were included in the study. Five towns (both urban and rural) in each county or city were selected for inclusion in the study. The most central town of each region was included, as were towns to the north, south, east, and west of the center of the region. One administrative village was randomly selected within each town included in the investigation.

Schoolchildren aged 8–12 years were enrolled at each investigation site from May 2016 to October 2016. Only one primary school in each town was included in the investigation. Baseline information of the children from each primary school was obtained. If an investigation site had only one water source, that source was sampled. If an investigation site had multiple water sources, all of them were sampled. More than five brick tea water samples were collected at each investigation site. Brick tea samples were collected in each survey site. Water and brick tea water samples were collected in 15 mL centrifuge tubes and stored at 4 °C. Brick tea samples were collected in envelopes.

DF was diagnosed *via* the modified dean index criteria. The DF classifications in the current study included normal, questionable, very mild, mild, moderate, and severe. Scores of normal to severe were as follows: normal = 0, questionable = 0.5, very mild = 1, mild = 2, moderate = 3, and severe = 4. The schoolchildren all underwent clinical examinations

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under natural light by two specialists. According to the national criteria of China (WS/T 208-2011), DF detection rate is a quantitative indication of the prevalence of DF in a district, the DF index indicates the epidemiological scope of the disease (Graph 1), in increments defined as negative (0.0, < 0.4), borderline (0.4, < 0.6), mild (0.6, < 1.0), moderate (1.0, < 2.0), and severe (2.0–3.0).

The fluoride content of water samples, brick tea, and brick tea water were measured as described in the national criteria of China (GB/T 5750.2-1996).

All data were analyzed using SPSS 17.0 software. Qualitative data were analyzed using the chi-square test. Quantitative data that were normally distributed were analyzed with the use of *t*-tests or one-way analysis of variance, and quantitative data that were not normally distributed were analyzed using non-parametric tests.

In Haidong City, 2,677 schoolchildren were examined, and the DF detection rate was 15.09% (404/2,677) and the DF index was 0.26. In Hainan Prefecture, 3,975 schoolchildren were examined, and the DF detection rate was 14.06% (559/3,975) and the DF index was 0.24. In Yushu Prefecture, 4,790 schoolchildren were examined, and the DF detection rate was 32.61% (1,562/4,790) and the DF index was 0.55. In Yushu Prefecture, epidemical scope was borderline, and in Haidong City and Hainan Prefecture, it was negative (Table 1). The prevalence of DF differed significantly in the three regions investigated (χ^2 = 533.383, P < 0.001). The prevalence of DF was significantly higher in children in the Yushu Prefecture than those in the Hainan Prefecture (P < 0.05) and Haidong City (P < 0.05). Supplementary Table S1 (available in www.besjournal.com).

Fifty-seven drinking water samples were obtained in Yushu Prefecture, forty-eight in Hainan Prefecture, and twenty-seven in Haidong City, and all of them had fluoride contents of < 0.3 mg/L, < 1.0 mg/L, and < 0.5 mg/L, respectively. Thus, all samples tested were below the national maximum for drinking water of 1.0 mg/L.

The mean fluoride content of brick tea in the three regions differed significantly (F = 38.281, P < 0.001), and all three means were above the national standard. In Haidong City, Hainan Prefecture, and Yushu Prefecture, the median fluoride contents of brick tea water were 0.730 mg/kg, 1.175 mg/kg, and 2.275 mg/kg, respectively. There was a significant difference between the median fluoride content of brick tea water in the three regions at different altitudes (χ^2 = 585.12, P < 0.001). (Table 2).

Suitable fluoride intake can prevent caries with

Table 1. Comparison of DF in schoolchildren aged 8–12 years in different regions

Regions	Number	Dental fluorosis						Detectable rate %	DF index
		Normal	Questionable	Very mild	Mild	Moderate	Severe		
Haidong city	2,677	1,957	316	286	102	16	0	15.09[a]	0.26
Hainan prefecture	3,975	308	333	350	174	34	1	14.06[a]	0.24
Yushu prefecture	4,790	2,877	351	853	528	177	4	32.61	0.55
χ^2				533.383					
P value				< 0.001					

Note. [a]P < 0.05 compared with Yushu prefecture.

Table 2. Fluoride content of brick tea and brick tea water

Regions	Brick tea (mg/kg)			Brick tea water (mg/kg)		
	N	Mean	Range	*N*	Median	Range
Haidong city	56	724.71 ± 322.25[a,b]	210–1,866	189	0.73[a,b]	0.2–11.99
Hainan prefecture	79	882.37 ± 404.71[a]	106–2,094	1,239	1.175[a]	0.4–8.19
Yushu prefecture	34	1467.00 ± 279.20	720–2,240	658	2.275	0.2–17.47
F/ χ^2		38.281			585.12	
P value		< 0.001			< 0.001	

Note. [a]P < 0.05 compared with Yushu prefecture; [b]P < 0.05 compared with Hainan prefecture.

the addition of fluoride into toothpaste, milk, and salt so as to provide its desired amount to the population. However, fluoride has a very narrow safety margin between its optimum benefit for caries prevention and chronic fluoride intoxication[5].

DF occurs due to high ingestion of fluoride during childhood. Generally, children drink tap water, of which fluoride intake are suitable. However, if children take in brick tea water which contain high fluoride content, the high fluoride from brick tea can cause fluorosis (DF and SF)[6]. Qinghai Province in the Qinghai-Tibet Plateau and local population have the habit of consuming brick tea. The main method of drinking brick tea is to mix with water or milk. The fluoride content of brick tea is much higher than that of other food. Owing to its cold climate, the ingestion of brick tea is high in Qinghai Province, and the fluoride intake of brick tea drinkers may exceed the nationally advocated safe level. Those who drink brick tea for a long time may be chronically exposed to high levels of fluoride, and be at risk of developing brick tea-type fluorosis[7].

In the present cross-sectional investigation, the prevalence of DF in Yushu Prefecture was significantly higher than that of the other two other regions. The main causes of this are likely to be Yushu Prefecture's cold climate. Although most children were living in dormitories on campus and are generally not in the habit of drinking brick tea, schoolchildren in Yushu Prefecture often drink brick tea to resist cold[3]. Local children in both Hainan Prefecture and Haidong city tend to drink tap water, of which the mean fluoride content was below the national standard maximum for drinking water (1.0 mg/L). Therefore, the prevalence of DF in Yushu Prefecture was higher than that of Hainan Prefecture and Haidong city. The poor quality of brick tea was another potential cause of the comparatively high prevalence of DF in schoolchildren in Yushu Prefecture. The fluoride content of brick tea exceeded the national standard applicable in China (300 mg/kg), thus, more fluoride was ingested by schoolchildren through brick tea consumption. Overall, the prevalence of DF among schoolchildren in the study was mild, which is consistent with the results of previous epidemiological investigations[8]. However, our data show that schoolchildren in Yushu Prefecture were at high risk due to excessive fluorine intake from drinking brick-tea water

By way of customs, habits, and living environments of ethnic minorities, brick tea is a regular part of their diets, and brick tea-type fluorosis is a major public health problem in the western part of China[9]. Cao et al.[10] reported that 94% of the total intake of fluorine by Tibetan adults and children could be attributed to brick tea. When children predominantly drank brick tea with a low-fluorine content their total daily fluoride intake fell to within the nationally advocated safe range.

In summary, the current cross-sectional investigation of brick tea-type fluorosis in Qinghai Province, China, the prevalence of the condition in schoolchildren aged 8–12 years was relatively low, and schoolchildren in Yushu Prefecture were affected by drinking brick tea water.

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Supplementary Table S1. Prevalence of DF in schoolchildren aged 8–12 years in three regions

Regions	County	Number	Dental fluorosis						Detectable rate %	Index
			Normal	Questional	Very mild	Mild	Moderate	Severe		
Haidong city	Huzhu	370	273	50	39	7	1	0	12.70	0.22
	Pingan	352	225	65	50	10	2	0	17.61	0.49
	Minghe	395	263	65	43	20	4	0	16.96	0.32
	Hualong	334	212	59	45	15	3	0	18.86	0.34
	Xunhua	922	799	32	64	24	3	0	9.87	0.15
	Ledu	304	185	45	45	26	3	0	24.34	0.42
Hainan prefecture	Guide	1,308	1,009	102	116	64	17	0	15.06	0.26
	Guinan	1,032	848	73	71	36	3	1	10.76	0.19
	Xinghai	506	373	56	56	19	2	0	15.22	0.25
	Gonghe	609	471	47	53	35	3	0	14.94	0.26
	Tongde	520	382	55	54	20	9	0	15.96	0.28
Yushu prefecture	Yushu	272	121	41	64	36	10	0	40.44	0.69
	Zhiduo	1,364	850	30	262	156	62	4	35.48	0.58
	Qumalai	446	230	62	68	62	24	0	34.53	0.66
	Chenduo	1,230	769	127	197	100	37	0	27.15	0.46
	Zaduo	217	105	22	46	32	12	0	41.47	0.72
	Nangqian	1,261	802	69	216	142	32	0	30.93	0.5