EPIDEMIOLOGICAL AND RADIOLOGICAL STUDY OF SKELETAL FLUOROSIS IN MINZHU TOWN, LONGLI COUNTY, GUIZHOU PROVINCE, CHINA

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SUMMARY: A study was made of an area of endemic fluorosis based on the relation between detection rate or incidence, classification and severity of skeletal fluorosis, and sex-age distribution. The results show that Minzhu Town of Longli County is a moderate and typical epidemic area of endemic fluorosis resulting from coal-burning pollution in Guizhou Province, China. Five features characterize skeletal fluorosis of the residents: (1) Osteosclerosis is significantly more prevalent than osteoporosis. (2) No mixed type of skeletal fluorosis and no osteomalacia were found in the subjects examined. (3) No cases with moderate or severe osteoporosis were found. (4) The severity of osteosclerosis in females was significantly milder than in males. (5) The rate of osteoporosis caused by fluoride in females showed no difference from that in males. These observations provide new parameters for assessing collective conditions of epidemic regions of endemic fluorosis resulting from coal-burning pollution.

Keywords: Coal-burning pollution, Dental fluorosis, Endemic fluorosis, Fluoride intake, Guizhou Province (China), Osteoporosis, Osteosclerosis, Skeletal fluorosis.

INTRODUCTION

Skeletal fluorosis, a critical criterion for diagnosing endemic fluorosis, is also the most important parameter for assessment of an epidemic area.[1] Not only do the detection rate or incidence and severity of skeletal fluorosis differ, but the classification and sex-age distribution also vary with different epidemic regions. Elucidation of the relation between them would greatly assist in assessment of epidemic regions and in control of the prevalence. The present study attempts to provide basic information for this approach.

GENERAL CONDITION OF INVESTIGATION SITE

Minzhu Town of Longli County, located in the southwest part of Guizhou Province, China, ranges in altitude from 1550 to 1700 m, with an annual average temperature of 14.7°C, a yearly average rainfall of 1,100 mm, and relative humidity above 80 percent.

The villagers habitually make and use a simple inverted (non-chimney) stove or non-pipe ground stove to burn coal for daily life. The crop harvested in autumn needs to be dehydrated in a short time to prevent rotting and mildew because of the cold weather and humidity. However, the housing conditions are generally simple and rustic with poor insulation of the floor or roof ceiling. Without a special storage facility or a warm room for their harvested crop, the villagers put the crop on the floor or roof ceiling. They believe this

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to be an ideal storage place because the crop may thus be dried gradually by the coal fire.

Minzhu Town has a total population of 1612 and 336 families. Generally, the diet consists of 70% rice and 30% corn as the main staples.

METHODS

The community index of dental fluorosis, urine fluoride level, symptoms and signs of clinical fluorosis, fluoride content in indoor air, and fluoride content in the staple food were examined and detected by the national standard method described in the Handbook of Control of Endemic Fluorosis issued by the China Ministry of Public Health.[2] Skeletal fluorosis was analysed by group reading of a set of x-ray films including thorax, spinal vertebrae, pelvis, right upper arm, and lower leg taken on each subject.

Estimation of total fluoride intake: The total daily fluoride intake per person was calculated according to the following parameters. Intake of staple food: 70% of rice and 30% of corn, totalled 0.5 kg per person/day. Intake of fresh vegetables was: 0.5 kg per person/day. Intake of drinking water: 2 L of water per person/day. Intake of baked chili: 0.0035 kg is ingested per person/day. Intake of air: respiratory capacity of 12 m^3/day, indoor activities of 16 hours and outdoor activities of 8 hours.

RESULTS

Detection of dental fluorosis in children: Among 150 children examined, 135 (90%) were diagnosed with dental fluorosis. There were 5 questionable cases, 17 very mild cases (11.3%), 40 mild (26.7%), 51 moderate (34.0%), and 27 severe (18.0%). These give a Dean-scale community fluorosis index of 2.4. There was no difference between age-dependent distribution and detection rate, with all over 90%, except for lower detection in the group aged 8 and below.

Level of urinary fluoride in children: The level of fluoride in the urine of children aged 8-12 was 3.16 ± 1.87 mg/L (n = 100). Mean level in the group aged 8 was 1.86 mg/L, and in the age group of 12 it was 4.17 mg/L, showing a significant difference between the two groups ($p < 0.05$).

Detection and incidence of clinical fluorosis: 556 residents were examined and 318 cases were found, for a detection rate of 57.2%. A lower detection rate and milder cases were seen in the group under age 36. In contrast, a higher detection rate and more advanced cases were found in the older age group. The detection rate of severe cases was 12%. No very severe cases were found.

Detection of degrees of skeletal fluorosis and age-sex distribution (Table 1): 66 cases with skeletal fluorosis out of 120 examined subjects were diagnosed for a total detection rate of 55%, in which osteosclerosis accounts for 44 cases (66.67%) and osteoporosis 22 (33.33%) ($\chi^2 = 17.61$, $p < 0.0005$). Detection of skeletal fluorosis in males was 74.1% and in females 39.4% ($\chi^2 = 13.59$, $p < 0.005$). None of the two classifications of mixed type and osteomalacia were detected. In the degree of osteosclerosis and distribution (Table 2), the female cases were significantly less in severity and fewer in number than male cases

(χ^2 = 6.83, p <0.05). No female cases with severe osteosclerosis were found. In the degree of osteoporosis and sex distribution (Table 3), there was no significant difference between sex distribution, and no cases with moderate or severe osteoporosis were detected.

Table 1. Degree of total skeletal fluorosis and age-sex distribution

Age	Sex	Number checked	Very mild (%)	Mild (%)	Moderate (%)	Severe (%)	Cases (%)
16-25	M	11	2 (18.2)	0	0	1 (9.1)	3 (27.3)
	F	11	1 (9.1)	0	0	0	1 (9.1)
26-35	M	8	1 (12.5)	3 (37.5)	3 (37.5)	0	7 (87.5)
	F	19	0	1 (5.3)	0	0	1 (5.3)
36-45	M	10	1 (10.0)	5 (50.0)	1 (10.0)	1 (10.0)	8 (80.0)
	F	13	2 (15.4)	2 (15.4)	2 (15.4)	0	6 (46.2)
46-55	M	15	2 (13.3)	5 (33.3)	3 (20.0)	3 (20.0)	13 (86.7)
	F	10	3 (30.0)	4 (40.0)	1 (10.0)	0	8 (80.0)
56 +	M	10	0	4 (40.0)	4 (40.0)	1 (10.0)	9 (90.0)
	F	13	1 (7.7)	7 (53.8)	2 (15.4)	0	10 (76.9)
*	M	54	6 (11.1)	17 (31.5)	11 (20.4)	6 (11.1)	40 (74.1)
Total	F	66	7 (10.6)	14 (21.2)	5 (7.6)	0	26 (39.4)
Total		120	13(10.8)	31(25.8)	16(13.3)	6(5.0)	66 (55.0)

*P <0.005 (χ^2 = 13.59, compared between sex).

Table 2. Degree of osteosclerosis and age-sex distribution

Age	Sex	Number checked	Very mild (%)	Mild (%)	Moderate (%)	Severe (%)	Cases (%)
16-25	M	11	2 (18.2)	0	0	1 (9.1)	3 (27.3)
	F	11	1 (9.1)	0	0	0	1 (9.1)
26-35	M	8	0	1 (12.5)	3 (37.5)	0	4 (50.0)
	F	19	0	0	0	0	0
36-45	M	10	1 (10.0)	3 (30.0)	1 (10.0)	1 (10.0)	6 (60.0)
	F	13	2 (15.4)	2 (15.4)	2 (15.4)	0	6 (46.2)
46-55	M	15	0	2 (13.3)	3 (20.0)	3 (20.0)	8 (53.3)
	F	10	1 (10.0)	3 (30.0)	1 (10.0)	0	5 (50.0)
56 +	M	10	0	1 (10.0)	4 (40.0)	1 (10.0)	6 (60.0)
	F	13	1 (7.7)	2 (15.4)	2 (15.4)	0	5 (38.5)
*	M	54	3 (5.6)	7 (13.0)	11 (20.4)	6 (11.1)	27 (50.0)
Total	F	66	5 (7.6)	7 (10.6)	5 (7.6)	0	17 (25.8)
Total†		120	8 (6.7)	14 (11.7)	16 (13.3)	6 (5)	44 (36.7)

*P <0.005 (χ^2 = 6.83, compared between sex);
†P <0.0005 (χ^2 = 17.61, compared with osteoporosis).

Table 3. Degree of osteoporosis and age-sex distribution

Age	Sex	Number checked	Very mild (%)	Mild (%)	Cases (%)
16-25	M	11	0	0	0
	F	11	0	0	0
26-35	M	8	1 (12.5)	2 (25.0)	3 (37.5)
	F	19	0	1 (5.3)	1 (5.3)
36-45	M	10	0	2 (20.0)	2 (20.0)
	F	13	0	0	0
46-55	M	15	2 (13.3)	3 (20.0	5 (33.3)
	F	10	2 (20.0)	1 (10.0)	3 (30.0)
56 +	M	10	0	3 (30.0)	3 (30.0)
	F	13	0	5 (38.5)	5 (38.5)
Total	M	54	3 (5.6)	10 (18.5)	13 (24.1)
	F	66	2 (3.0)	7 (10.6)	9 (13.6)
Total		120	5 (4.2)	17 (14.2)	22 (18.3)

DISCUSSION

As a result of pollution from coal burning, the daily mean level and single maximum level of fluoride in indoor air were 0.01886 and 0.07316 mg/m^3, respectively, or several times those of the national standards (0.007 and 0.02 mg/m^3, respectively). The fluoride content of corn baked by coal burning increased over 3 months to 15.56 mg/kg and that of chaff rice stored over 6 months indoors increased to 2.53 mg/kg. The fluoride content of the baked chili (hot pepper) increased to 363.93 mg/kg. It is estimated that the total daily fluoride intake per person is as high as 4 to 6 mg, and more than 70% of the total intake is derived from the main staple foods (rice and corn) and chili. These findings indicate that the prevalence of endemic fluorosis in the investigation site is the same as in other epidemic regions of Guizhou Province. It is therefore an epidemic area of endemic fluorosis resulting from coal-burning pollution with a prevalent pathway: burning coal with a non-chimney stove → fluoride released in large quantity → polluting indoor air → polluting stored crop (mainly corn and chili) → ingestion into body → fluorosis.

All the parameters, including mean urine fluoride level of 3.16 mg/L, dental fluorosis detection of 90% with a community index of 2.4, detection of clinical fluorosis of 57.2% and detection of skeletal fluorosis of 55% are not up to the levels of severe endemic regions of Guizhou Province.[1] According to the classification standard for an epidemic area by the Handbook,[2] Minzhu Town is a moderate epidemic area of coal-burning pollution endemic fluorosis.

A previous study revealed that there was no difference between gender in the occurrence of skeletal fluorosis, but more female than male cases with osteoporosis were seen in severe epidemic areas of Guizhou Province.[3] In the present study, the results show that females have less and milder skeletal fluo-

rosis than males, with no significant difference in osteoporosis between males and females.

The comparison also reveals that the difference between sex distribution in the rate and degree of skeletal fluorosis reflects differences in collective conditions in different epidemic regions. We believe this diversity results mainly from differences in the epidemic areas, such as education, economy, food constitution, and nutrition, apart from total fluoride intake. Residents in the severe fluorosis epidemic areas of the southwest part of Guizhou have a mean total fluoride intake above 10 mg/person/day. They are not economically well off, consuming corn as their main food, and are in poor condition nutritionally. Women especially are mostly calcium deficient.

However, the residents of Minzhu Town in the present study consume rice as their main food and have relatively better nutrition, which is an important factor for less and milder osteoporosis and decreased skeletal fluorosis. Other important findings are that no osteomalacia, no mixed type of skeletal fluorosis in the classification, and no severe cases of skeletal fluorosis were seen in females in the present study. These facts also indicate that classification and degree of skeletal fluorosis and age-sex distribution including total fluoride intake should be taken into account in assessment of an endemic area.

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