RELATIONS BETWEEN ENVIRONMENT AND ENDEMIC FLUOROSIS IN HOHHOT REGION, INNER MONGOLIA

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SUMMARY: Results are reported of a comprehensive investigation into fluoride levels in drinking water and other environmental characteristics, and their relation to endemic fluorosis, in Hohhot Region, Inner Mongolia.

Key words: Drinking water fluoride; Environment, Hohhot; Inner Mongolia.

INTRODUCTION

Research has shown that high-fluoride content in drinking water is the major cause of endemic fluorosis.[1-5] It is estimated that drinking water is responsible for 65% of endemic fluorosis in the world. It is important to determine the sources of fluoride in the environment. Consequently a comprehensive investigation was carried out on the element fluorine in drinking water and other related environmental characteristics in the Hohhot Region, Inner Mongolia.

MATERIALS AND METHODS

Results were obtained of comprehensive investigations into the fluorine content of water, soil and food in the Hohhot Region, Inner Mongolia, carried out by the Fifth Research Institute of the Ministry of Nuclear Industry, together with a complete analysis of all elements.

General description of Hohhot

Hohhot is located in the alluvial and diluvial plain made by the Daheihe River, the Xiaoheihe River and the Shirawusu River, with the middle range of the Yingshang mountains in the North and the Yellow River in the South. The plain terrain, bad conditions for water flow, and strong evaporation, result in extensive saline-alkali soils in the low-lying regions.

Hohhot has three counties including 45 townships. In 28 townships are located 412 villages which are the fluorosis endemic regions. The people threatened by fluorosis are 310,000 in number. Of these it is estimated that 246,015 suffer from fluorosed teeth (over 79%) and 41,235 have skeletal fluorosis (13.3%).

RESULTS AND DISCUSSION

Differences between endemic and non-endemic regions

Fluorine content in air, water and food was determined to establish the importance of each as a source of fluoride in the human body. In both the endemic and non-endemic regions the mean value of fluorine content in air was less than 0.007 mg/m^3. The fluorine content in the grains and vegetables such as corn, broomcorn millet, millet, Chinese sorghum and potato was between 0.013 and 0.09 mg/kg, with no clear variation in the values between the two regions. The incidence of fluorosis increased as the level of fluoride in drinking water increased, with a positive linear interrelationship ($r=0.8781$, $p < 0.01$) between the two. So we are certain that the fluorosis found was a result of fluoride in the drinking water (see Table 1).

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Relations between land features and fluorosis

Analysis for fluorine content in 1109 drinking water sources showed that the fluorine content is generally below 1.0 mg/L, thus complying with the national standard, in the wells used for drinking water in the Daqingshang Mountain Ranges. There is a tendency for fluorine content of drinking water to increase as the topographical slope decreases, where concentrations as high as 4 mg/L occur. However, in these sloping regions fewer than 4% of the water sources investigated exceeded the standard 1 mg/L. The highest concentrations occur in the plains, where more than 77.11%. of the water sources surpassed the national standard (1 mg/L) and almost 22% exceeded 4 mg/L (see Table 2).

The accumulation of fluorine in the ground water is an earth-chemical process accompanied by depositions of chemicals in the water. High fluorine water is usually found in the plains regions where the ground water level is 3-8 metres deep. Fluorine both in the deeper ground water and the shallow-level ground water came mainly from high-fluorine ores in the northern Daqingshang Mountains (fluorspar, apatite, hornblendre, mica, granite).

Relations between stratum depth and fluorine content of water

In the investigated water sources, the water in the different stratum depths contained various concentrations of fluorine, with surface water and shallow-stratum ground water containing higher concentrations of 5-11 mg/L. The fluorine content gradually decreases as the stratum depth increases. The fluorine content is 1-6 mg/L in wells 30-90 metres deep, and 0.25-2.5 mg/L at 90-150 metres.

Analyses of water quality and elements

Water hardness tests, and elemental analyses for F, K, Na, Ca, Mg, Al, Mn, Zn, Fe, As, Cr, Se, Pb, HCO_3^-, SO_4^{2-}, P, Cu, Se and Cd, were carried out to determine the quality of the water sources. The contents of Se, Pb, Zn and Cd were much lower than the National Sanitation Standard, while F content was positively correlated with content of Na, K, Cl, SO_4^{2-}, Cr and Cu. A negative correlation was found with Ca, ($r = 0.664$, $p < 0.05$). pH and HCO_3^- go up as the fluorine content increases, with the water having a slight basic pH. Increases in F, Na and Cl are normal in high-fluorine regions. The influence of other elements should not be neglected, but F must be regarded as the important environmental factor leading to fluorosis.

Fluorine content in soil

The total fluorine content of soil in the Hohhot region is 103-310 mg/kg with soil pH a little basic. The soil in the endemic region is saline-alkali. This type of soil has greater viscosity and poorer permeability. The slow water permeability enhances the accumulation of fluorine. Therefore the more rapidly the soil becomes saline-alkali, the more fluorine accumulates in the soil and the more severe the fluorosis in the endemic regions where such conditions occur.

The high-fluorine regions result from many factors: natural terrain, migration and supply of high-content fluorine ores, level land with poor conditions for water penetration, dry climate with strong winds and little rainfall, severe evaporation and concentration, and sodium-alkali soil. These conditions enhance the accumulation of elements such as F, Na, and Cl, and the forming of a high-fluorine geographical environment.

TABLE 1. Relation between fluorine content of drinking water and fluorosis.

Fluoride content of drinking water	individuals examined	dental fluorosis cases	dental fluorosis %	skeletal fluorosis cases	skeletal fluorosis %
0.4	1046	128	12.23	0	0.00
0.65	941	126	13.39	2	0.21
1.4	1204	758	62.96	93	7.72
1.6	889	680	76.49	109	12.26
3.2	798	622	77.94	101	12.66
3.4	866	715	82.56	132	15.24
4.7	214	197	92.06	42	19.63
6.9	834	795	95.32	166	19.90
Total	6792	4021	59.20	645	9.50

TABLE 2. Relation between F content of drinking water and geographical features

Region	Water sources No.	Fluorine content (mg/L) 0- No.(%)	1- No.(%)	2- No.(%)	3- No.(%)	4- No.(%)	5- No.(%)	6- No.(%)	7- No.(%)	8- No.(%)	Exceed standard (1 mg/L) %
Plain	568	130(22.89)	148(26.06)	98(17.25)	68(11.97)	47(8.27)	32(5.63)	19(3.35)	11(1.94)	15(2.64)	77.11
Sloping	373	358(95.98)	10(2.65)	3(0.60)	1(0.27)	1(0.27)					4.02
Mountain	158	158(100)									
Sum	1109	656(59.24)	158(14.25)	101(9.11)	69(6.22)	48(4.33)	32(2.89)	19(1.71)	110.99)	15(1.35)	40.85

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