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Chemical endemic diseases and their impact on population in china

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Abstract — This paper deals with some endemic diseases related to selenium, iodine and fluoride in eco–environment. Keshan disease and Kaschin–Beck disease are associated with low selenium, they mainly occur in a belt zone across China ranging from North–East to South–West. Selenium contents in food grains and human hair from the disease affected areas are usually below 0.020ppm and 0.20ppm respectively. The endemic goitre caused by iodine deficiency distributes extensively in China, mainly in mountainous and hilly districts, swamp and peat areas, some sand soil and limestone areas. Also there is another kind of endemic goitre which caused by iodine excess in interior and coast areas. Endemic cretinism usually occurs in the endemic goitre seriously affected areas. Endemic fluorosis is also widely distributed in China, but mainly occurs in dry or semi–dry areas of north China. The fluoride sources for causing endemic fluorisis are drinking water and food grains polluted by coal smoke in the backing process of maize and chilli.

Keywords: endemic disease; Selenium; Iodine; fluorosis.

INTRODUCTION

Chemical endemic disease is a kind of disease which is closely associated with geographical environment. Its occurrence mainly arises from the abnormal amount, i.e., deficiency, excess or imbalance of chemical elements in the environment.

Human beings are the end product of a long process of evolution and natural selection–the interaction of biological life forms with their surroundings. They obtain the energy and material from the environment for supporting their life process–growth, development and reproduction, and maintain an exchange of energy and material (including various chemical elements) with the environment. If this exchange were upset, the human health would be influenced. As is well known, so that the distribution of chemical elements in the environment exhibits obvious regional differences. When the chemical elements in the environment occur at abnormal levels, the normal exchange of chemical elements between human and the environment may be broken that result in some endemic diseases induced by the element deficiency or excess in the environment. Such diseases are defined as chemical endemic diseases to differentiate from those induced by physical or biological factors.

China has a vast territory with a complex and varied natural environment and there is certainly a great geographical variation of chemical elements in the environment. In addition, most of population live in rural areas where their drinking water, food, and even inhalating air are all deeply influenced by chemical constituents in the local environment. Therefore, in China, the great change in environmental chemical elements has led to many kinds of endemic diseases in different places, becoming an important natural disaster over a large affected area. They mainly include those endemic diseases induced by a deficiency or excess of selenium, iodine, fluoride etc. in the environment, such as Keshan disease (KSD), Kaschin–Beck disease (KBD),

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endemic goitre, endemic cretinism, endemic fluorosis, endemic arsenic poisoning and endemic selenosis. Chemical endemic disease not only obviously influence the quantity of population, but also impair the quality and structure of population, and hamper economic development in affected regions.

ENVIRONMENTAL SELENIUM, ENDEMIC DISEASES AND POPULATION

Selenium was not recognized to be an essential element to living beings until 1957 (Schwarz, 1957). It had been considered previously as a toxic element. As is now well known, environments with low selenium can cause a series of selenium-responsive diseases in animals, such as muscular dystrophy in sheep and cattle, white muscle disease in lambs, exudative diathesis in chickens, liver necrosis in swine and rats etc. But the direct evidences for explaining the effect of selenium deficiency on human health were found from China. In the country two endemic diseases, Keshan disease and Kaschin-Beck disease, were found to be closely linked with the environment having very low selenium in the 1970's (Group of Endemic Disease and Environment, 1974, 1976, 1979; Tan Jianan, 1984; Keshan Disease Research Group, 1979.).

Distribution

Keshan disease is an endemic cardiomyopathy in human that was being recorded in northeast China at the beginning of this century. In the winter of 1935 in Keshan county, Heilongjiang Province, the disease, known subsequently as Keshan disease, became prevalent and was later recognized in the North, the Northwest and the Southwest successively. So far, Keshan disease has been recorded in 309 counties in 15 provinces or autonomous regions of China, including Heilongjiang, Jilin, Liaoning, Inner Mongolia, Hebei, Shandong, Shanxi, Henan, Shaanxi, Gansu, Sichuan, Yunnan, Tibet, Hubei and Guizhou (Fig.1). It has also been reported in Korea. Fig.1 shows that Keshan disease is distributed in a fair belt ranging from the Northeast to the Southwest across China. This belt is usually called " disease belt " .

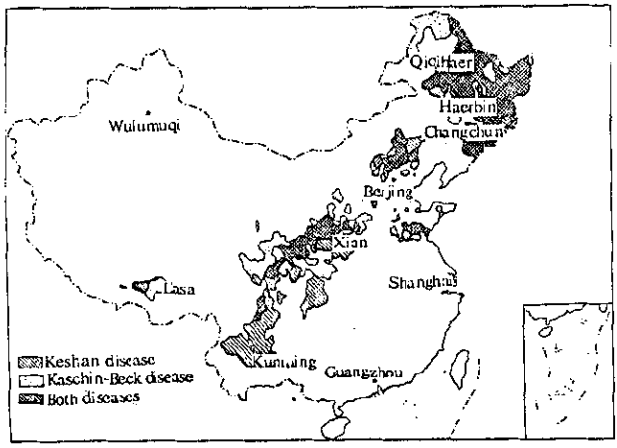

Fig.1 Distribution of Keshan disease and Kaschin-Beck disease in China

Kaschin-Beck disease is an endemic osteoarthropathy that occurs mainly in the eastern Siberia and in certain parts of China. Records of a disease similar to deformity endemic were reported in " Annals of Anze County, Shanxi Province " in 1664. Furthermore a Russian, I.M.Uranskii, reported in 1849 that many dwarfs were found in Urov Drainge Basin of Transbaikalia region, Siberia; the doctors H.I.Kaschin and E.V. Beck investigated the disease between 1855-1902 that afterwards was named after both their names. But in China people usually call

it " enlarged bone joint disease " . Kaschin-Beck disease distribution is similar to that of Keshan disease, mainly occurring in 303 counties in 15 provinces (or autonomous regions, or municipalities), including Heilongjiang, jilin, Liaoning, Inner Mongolia, Hebei, Beijing, Shandong, Shanxi, Henan, Shaanxi, Gansu, Qinghai, Sichuan, Tibet and Taiwan (Fig. 1). Likewise its distribution also forms a broad belt extending from northeast to southwest China.

Association with environment

As mentioned above, the two diseases have similar and regular distributions and show that there is a close relationship between the disease and certain environments. It was found that the environments having disease belts are different from those having non-disease belts out sides. The affected belt lies in or near the environments with brown-drab soil series, mainly including dark forest soil, brown taiga, black earth, brown earth, drab soil, black loessial soil (Helutu), forest steppe soil, purplish soil, red-drab soil, red-brown earth, yellow-brown earth etc; while the non-disease belt to the Northwest is covered by typical steppe and desert zones, and the one to the Southeast by typical yellow and red earth zones. As a result, three belts can be distinguished, one affected belt and two nonaffected belts. Even within the affected belt, the occurrence is interrupted, being located mainly on hilly areas, ridges and small basins or plains, with a common characteristic of low selenium in the environment. The population in affected areas is in Se-deficient situations at low levels of selenium in the ecological cycle. This means that from soil through foodgrains to human body the selenium flux is very small (Table 1). Based on our researches in affected areas, selenium contents are usually less than 0.17 ppm in soils, less than 0.025 ppm in cereals (maize, rice, wheat etc.), less than 0.20 ppm in hair, less than 0.03 ppm in whole blood (Tan Jianan, 1984)

Table 1 The relation of Keshan disease and Kaschin-Beck disease to selenium in soils, grains and hair

Belts/ Regions	Selenium Content, ppm				
	Soil	Maize	Rice	Wheat	Hair
1. NW Belt	0.19(29)	0.049(69)	0.087(25)	0.106(157)	0.379(371)
2. Middle Belt	0.13(80)	0.016(230)	0.022(120)	0.021(272)	0.129(1412)
-KSD/KBD					
-Mixed area	0.17(5)	0.014(8)	0.012(5)	0.14(56)	
-KSD Area	0.09(16)	0.013(55)	0.011(51)	0.018(72)	0.085(851)
-KBD Area	0.09(15)	0.09(3)		0.011(27)	
-Non-affected	0.09(23)	0.019(91)	0.031(64)	0.026(117)	0.187(597)
3.SE Belt	0.23(77)	0.053(16)	0.063(256)	0.056(71)	0.378(245)

Note: Values for soil Se are geometric means, and others are arithmetic means. Digits in parentheses are number of samples. Tan Jianan, 1985

Impact on Population

Pathological changes associated with Keshan disease mainly involve the myocardium. Serious myocardium degeneration, necrosis and scar formation are indicated. Acute and chronic cardiac insufficiency, acute cardiac failure, heart enlargement, gallop rhythm arrhythmia, and electrocardiogram changes are the principal clinical manifestation. Agricultural people consuming locally produced grains and vegetables as their staple food are potentially designated as the major disease affected group. Rural peasants constitute the population at risk, of which children below ten years of age and women of child-bearing age are the most susceptible. The average annual incidence rate was about 9.3/100000 (acute and subacute) from 1959-1982. The disease attack is extremely sudden, the fatality rate was very high (over 40 per cent) before the 1960's. It is quite evident that the prevalence of Keshan disease would surely influence the normal development and composition of population in affected areas, but it is more important that it obviously influences the quality of population in affected area; damaged hearts are not easy to be recovered, and some patients have lost their ability to work to various extents.

Changes in the pathology of the joints occur all over the body among Kaschin–Beck disease patients, but the major effects relate to joint cartilage and epiphyseal plate cartilage of the four limbs. Principal changes are chondral degeneration and chondronecrosis as well as repair processes following necrosts. The major clinical symptoms of Kaschin–Beck disease are the joints of the four limbs becoming thickened, deformed, and difficult to crook or stretch, and muscles becoming atrophied. Just like Keshan disease, the rural residents consuming locally produced grain still constitute the population at risk. The morbidity rate may range from several to over 50 per cent while in some severely affected villages almost all the inhabitants can be affected to certain degree. Children and teenagers are more susceptible while there are no apparent differences between the sexes. Clearly, Kaschin-Beck disease has heavily influenced the normal body growth and development of affected populations, especially children, and has led to a considerable number of patients losing their ability to work. There are some 35 million people threatened by this disease and 1.76 million patients in the affected area. Therefore, its effect on human health and population quality is extensive and serious.

Since 1949 when the People's Republic of China was founded, especially in recent years, the living standards of the people in affected areas have been apparently risen, and the measure of selenium supplementation has been taken extensively for control of the two diseases among affected populaticns. Thus the incidence of Keshan disease has decreased sharply, down to 1.81/1,000,000 by 1982 (Huang Shuze, 1986). In a lot of affected areas the occurrence of new Kaschin–Beck disease patients has obviously declined, and has even been under control.

ENVIRONMENTAL IODINE, ENDEMIC DISEASE AND POPULATION

Iodine deficiency disease (IDD) includes mainly endemic goitre and endemic cretionism, and commonly occurs all over the world, except Iceland, According to WHO'S (1960) data there were no less than 200 million individuals affected by goitre in the world (Clements, 1960).

Distribution

The distribution of endemic goitre is very extensive in China (Fig.2), the disease is found in 1,550 counties of the 29 provinces (or autonomous regions, or municipalities), except for Shanghai municipality. The affected counties account for about 65 per cent of the total number of counties in China, of which 758 counties also relate to the endemic cretinism (Sun Xi, 1986).

Association with environment

The seriously affected areas are mainly distributed in the Da Xing'an and the Changbai mountainous areas in northeast China, the Yanshan mountainous areas in north China, Qinling–Daba and Dabie mountainous areas in central China, the Himalaya mountain area and the moutainous areas on the southwestern fringe of the Yunnan–Guizhou plateau in southwest China, the hilly areas of Nanling, and so on (Fig.2).

Based on the iodine conditions, there are four types of environment causing endemic goitre in China: (1) iodine-leached environments in mountainous and hilly areas; (2) iodine–fixed environments in some areas of swamp and peat; (3) iodine–leached environments in some areas of sand soil; (4) limestone environment. Besides the endemic goitre caused by iodine deficiency, the high iodine endemic goitre was successively discovered in the interior and coast of China after about 1978. This was caused by the habit of drinking high iodine deep groundwater in some counties along the Bohai Bay in Hebei and Shandong provinces, and both the deep and shallow groundwater in several low–lying interior areas in Xinjiang, Shanxi, and Hebei, or by eating Kelp, Kelp salt or salt made of Kelp in some coastal areas.

Impact on population

Tissue proliferation and degeneration are the two major pathological changes which take place in the gland tissue. In endemic goitre areas all of the residents are in a situation of low iodine cycle, and are subject to the risk from iodine deficiency. Some of them are retarded physically or intellectually to various degrees. When the goitre swells up to an appreciable

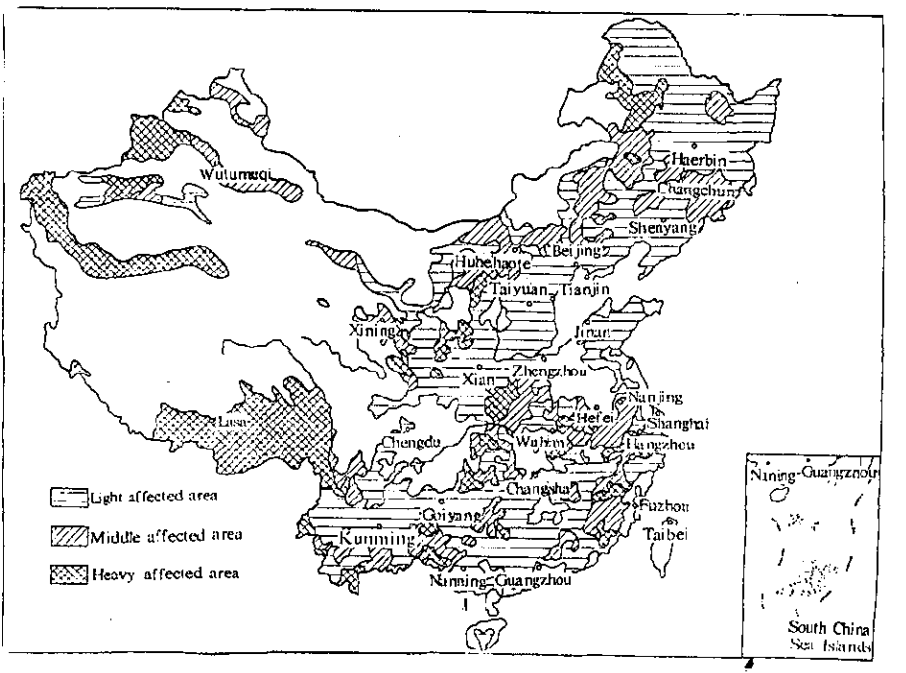

Fig.2 The map is adapted from the Atlas of Endemic Diseases and Their Environments in the People's Republic of China

extent and the tumour develops on the front of the neck, tracheary suppression results and breathing is difficult so that the ability to work will be influenced. In China there are more than 34 million patients suffering from endemic goitre, and 330 million people at risk of suffering from endemic goitre or cretinism in affected areas.

Endemic cretinism usually occurs in the same areas where are the endemic goitre seriously affected areas. Major clinical manifestations of endemic cretinism are characterized by dullness, dwarf, deafness and dumbness. In some seriously affected villages the prevalence rates of endemic cretinism are up to 10 per cent (Zhao Gangmin, 1986).

Thus iodine deficiency disease has an important impact upon population quality over extensive affected areas. Institutions at all levels from central to local government have been set up to form a nationwide network in China for controlling these disease. Iodized salt supply has been popularized. By the end of 1984, 11 provinces had complied with the " basic control " standard set by the Government and 740 counties had made preliminary control of the disease. By the year 2000, the aim of basic control of endemic goitre is expected to be realized in China.

ENVIRONMENTAL FLUORIDE, ENDEMIC DISEASE AND POPULATION

Distribution and association with environment

Endemic fluorosis is more widely distributed in China. Except shanghai, it is prevalent in about 71413 villages of 991 counties in the other 29 provinces (Fig.3). More than 72 million people are threatened by this disease. There are some 21 million patients of dental fluorosis, and about one million patients of skeletal fluorosis (Huang Shuze, 1986). Endemic fluorosis mainly occurs in arid and semi-arid areas of north China, including the wide region from the west of Heilongjiang to Xinjiang. In the south of China, endemic fluorosis occurs only in scattered high fluoried hot spring areas and those areas where the rich fluoride rock and mineral are situated.

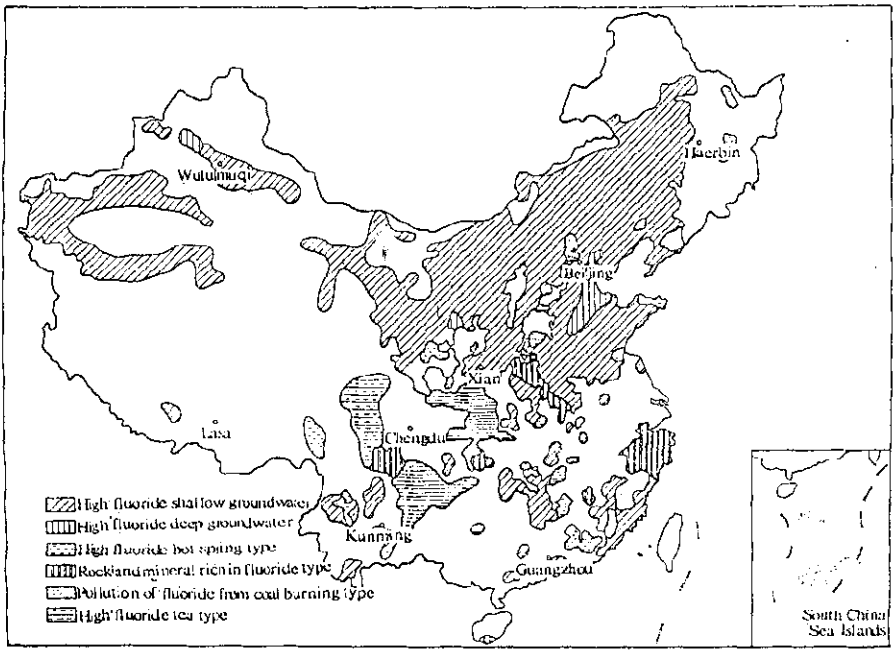

Fig.3 The map is adapted from the Atlas of Endemic Diseases and Their Environments in the People's Republic of China

The first fluoride source for endemic fluorosis in China is drinking water, and the second is food. There are four fluoride sources from drinking water: (1) Shallow high fluroide groundwater. In arid and semi-arid areas of China, the evaporation is strong that leads to high fluoride contents in groundwater. It is generally 5 mg/L, and may be up to 32 mg/L. The west of Inner Mongolia, the north of Shaanxi and Ningxia all belong to this type. For example, the fluroide content in drinking water is 7.4 mg/L in Shangjia village in Zhaodong county, Heilongjiang province, and the prevalence rate of dental fluorosis is 51.8 per cent of resident (Liu Changhan, 1984). (2) Deep high fluoride groundwater. In the coastal area of the Bohai Bay, fluoride contents in deep groundwater are very high due to the influence of the palaeogeographical environment. (3) High fluoride hot springs. In general, such hot springs have a small influence. (4) Fluoride abundant rock and minerals. Groundwater around fluorite mines and apatite mines has high fluoride contents. There are fluoride mines in Yixian county in Liaoning; Yiwu and Wuyi in Zhejiang; Fangcheng and Tongbai in Henan; and Ningdu in Jiangxi. Fluoride content is 2.8 mg/L in groundwater from Fanying village, Fangcheng county, Henan province (Li Ribang, 1982).

In some mountain areas of the southwest of China, people used to use coal to dry maize and chilli, which are in turn contaminated by fluroide released from the burning coal and thus their fluoride content are raised highly; e.g., the mean fluoride content of dried maize is 46.54 mg/kg in Zhijin county, Guizhou province, ten times that in normal maize (Li Ribang *et al.* 1982). Moreover fluoride content is 203.9 mg/kg in salt from Pengshui county (Liu Ziyue *et al.*, 1982), 622 mg/kg in brick tea and 2.76 mg/L in tea water from Rangtuang county (Bai Xuexin, 1986). Sichuan province. All of them result in fluorosis.

Impact on population

Fluorosis mainly makes inroads on teeth and bone of human beings, seriously harming

health and reducing population quality. Serious skeletal fluorosis patients become bent and hunchback, and it is difficult for them to walk. Their ability to work is reduced or disappears. Some lose the ability to take care of themselvers, becoming disabled. Shaanxi province is one of the serious fluorosis-affected areas in China, about three million persons were threatened by high fluoride in the whole province and the prevalence rate of dental fluorosis is 71.76 per cent and that of skeletal fluorosis 4.0 per cent (Zhu Jipu, 1982).

In China, many measures have been taken to control endemic fluorosis. In high fluoride drinking water area, two measures have been taken: first, low fluoride water is chosed for new drinking water supply; secondly, the method for removing fluoride is used to lower the fluoride content in drinking water. By 1983, 9108 projects of improving water and reducing fluoride had been completed in fluorosis affected areas in China, and 5,335,000 persons in affected areas have benefited (Huang Shuze, 1986). In recent years, these measures have developed further. In the other hand, the preventive experiment for improving kitchen ranges to reduce the food contamination by coal smoke has been studied.

CONCLUSION

World population has already been over five billions. Controlling its growth is a common concern for all countries. At the same time various disasters threaten to the safety of people and influence the normal development of population. Among them the chemical endemic diseases is an environmental harm to population in affected areas. It not only influences normal growth of population, but more seriously damages the population quality of disease-affected areas, e.g. appearance, heart function, bone tissues, metabolism and physiological function, and intelligence development. This kind of endemic disease disaster is different from other disasters, because its risk is kept in a lasting way. Moreover its influence is profound, not only on the quantity and quality of population, but also on socio-economic development of affected areas. If its harmful action could not be under control, the risk would continue from generation to generation. Of course, it is completely possible to control the harmful influences, and in China great progress has been made.

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