

The Comparative Analysis of Trace Element Character between Kashin-Beck Districts of Rangtang County and other Kashin-Beck Areas in China

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Abstract: Kashin-Beck is a disease which mainly harms articular cartilage and epiphyseal cartilage. A light Kashin-Beck disease is painful. It will influence laboring ability; A serious disease will make patients' limbs disabled, and make the patients lose laboring ability for the whole life. The pathogenesis of Kashin-Beck disease is complex, and no consensus has been reached on its' cause. Most scholars believe that there is some relationship between the Kashin-Beck disease and the drinking water in disease areas. This paper, based on the research of related references and the research in the disease areas of northwest Sichuan Plateau, discusses the relationship between the trace element in the water environment of disease areas and the cause of Kashin-Beck disease, to provide basic datas for the research on trace elements related to Kashin-Beck disease.

Key Words: Kashin-Beck disease, the trace element, northwest Sichuan plateau, Rangtang County

1、INTRODUCTION

Kashin-Beck disease is a kind disease of bone deformation in particular regions. It mainly affects children and teenagers who are in growth period of bones, causing damages to articular cartilage, epiphyseal cartilage, and eventually leading to bone necrosis, cartilage, bone swollen, and bone deformation. More than 50% of the patients lose laboring ability, which severely restricts economic development and people's living standard in the disease regions.

So far, the cause of Kashin-Beck disease is not clear. There are three theories which have been widely acknowledged: biogeochemical reason (low selenium), mycotoxin in food poisoning and water organic toxin poisoning^[1]. Zhilun Wang proposes the fourth hypothesis now: the B19 tiny viruses caused by the fourth environment conditions^[2]. All of above four theories have scientific basis. However, the theories of biological geochemistry, organic poisoning and tiny viruses all point out that the cause and the route of transmission are related to the geological environment and the quality of drinking water. So it is safe to conclude that the disease is closely related to the chemical characteristics of drinking water.

Studies show that drinking water's quality in disease areas is an important factor that causes Kashin-Beck disease. The residents drinking ditch water and river beach water had a high incidence for the disease and the clinical signs there were obvious^[3]. The research showed that the differences between drinking water in disease areas and water elsewhere were mainly the changes of water chemical composition of trace element in water.

Trace elements refer to the specific elements whose contents are below PPM in organisms, but play an impor-

tant role in people's life. So far, we have confirmed 14 kinds of trace elements: Cu、Fe、Mn、Zn、Co、Se、Cr、Sn、V、F、Ni、Si and Mo^[4]. The numbers of the trace elements in human body are very low. However, lack of them will cause people to get illnesses, and if excessive, they also can cause poisoning. Drinking water is a very important access to get trace elements. There are many literatures about the relationship between trace elements and the Kashin-Beck. Some researches have studied about the relevance between trace elements and the state of the illness, which is tabulated in Table 1.

This paper mainly takes a comparative analysis of the research results of water, which are taken from Kashin-Beck disease areas in Rangtang county in Aba, Sichuan province. Combined with previous research results, the paper hopes to find the relationship between the cause of Kashin-Beck disease and trace elements.

Table 1: Relevance between trace elements in drinking water and the state of the illness in some disease areas.

Place or village	trace elements in water related with the state of the illness in some wards	
	General related	Closely related
Linzhi of Tibet ^[6]		Se
yongshou county of shanxi province ^[7]	Mo、Pb、Zn、Fe、Mn、Cr、F	Se、Sr、Cu
YiMeng wushen banner township of Inner Mongolia ^[8]	Se、Mo、Zn、Fe、Mn、Al、Co、Ni、V、Cr、Ti	Se、Al、Co、Ni、V、Cr、Ti
Tibet ^[5]	Zn、Co、Al、Pb	Cu、Mn、Ba、Sr、Cd、V、Cr、Ni

NuoMin town in six or seven villages ¹⁹¹	Pb、Cu、Zn	Fe、Mn、Se
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2、SURVEY OF STUDY AREAS AND RESEARCH RESULTS

2.1 SURVEY OF STUDY AREAS

Research areas are mainly located in Rangtang County which is in the northern of Aba Tibetan and Qiang Minority Autonomous Region of sichuan province. Geographical coordinates of Rangtang County are between east longitude of 100°33'~101°29' and northern latitude of 37°28'~32°40'. RangTang County's area is 6863km², and its population is 335 million by the end of 2005. It contains 11 townships, 60 villages, 131 villager groups and minority groups of Qiang, Hui and Han.

Kashin-Beck-disease of Rangtang County in north-western Plateau of Sichuan is heavy. There are two rivers, Duke River and ZeQu River running though the region. According to the statistics of Epidemic Prevention Station, the number of patients with Kashin-Beck disease is 12484, which is 47.55% of the whole County's population. In 2002, we made X-ray radiography to 611 children aged 7 to 13. The number of masculine is 175, and the positive rate is 28.64%. So the district belongs to serious illness areas. over the watershed, the seriousness of the disease in Duke River is lower than that in ZeQu River.

2.2 INVESTIGATION RESULTS

- [1] In order to study the relationship between the glimmer characteristic indexes in water environment and the Kashin-Beck disease in the affected areas, we have taken a neutron activation analysis to the water samples, the result is tabulated in the table 2.

Table 2 Results of different types of water by the neutron activation analysis in Rangtang County

elements	ZeQu river	DuKe river	Water of Yangtze source river	elements	ZeQu river	DuKe river	Water of Yangtze source river
Fe	0.670	0.149	0.200	Eu	0.360	0.103	0.170
Na	1.150	0.892		Tb	0.340	0.091	0.140
K	0.713	0.142		Yb	0.923	0.177	0.370
Ca	13.505	23.520		Lu	0.132	0.022	0.067
Sc	4.727	0.291	2.100	As	7.820	6.778	
Cr	29.333	9.111	12.600	Sb	0.634	0.538	0.600
Co	5.167	0.735	0.940	Ag	0.116	0.288	
Ni	5.700	6.300	1.170	W	0.466	0.784	
Zn	83.273	140.600	6.460	Br	30.142	30.555	
Rb	39.833	4.375	31.23	Se	1.900	3.030	0.170
Sr	814.000	1145.020	1176.3	Au	0.445	0.523	
Cs	5.525	1.734	4.614	U	2.310	5.074	1.900
Ba	200.667	108.00	171.102	La	10.108	1.710	5.600
Zr	29.148	36.200		Ce	19.710	6.670	5.000
Hf	0.865	0.142		Nd	11.103	2.521	5.100
Ta	0.290	0.034		Sm	2.130	0.543	0.930
Th	4.070	0.324	2.000				

Note: (1) The unit of Fe、Na、K、Ca is %,the unit of Au is PPb, the unit of other elements is PPM;

(2) The data of elements in Yangtze Source River is quoted from the research by Zhangli Cheng and so on.

3 Analysis Of Featured Elements Of Trace Components In Water Environment Of Research Areas

3.1 Analysis of The Main Trace Elements Related With Illness In The Water Of Research Areas

Ri Sha, Tianzhi Sun etc.(1992) analyzed 21 kinds of elements in the Kashin-Beck disease areas, and determined that the amount of Al, Fe, Se among the trace elements in water in the disease areas was significantly lower than that in normal areas and the amount of Cu, Mn, Mo, P was higher. There is a relationship between elements of Se, Zn, Fe, Mo, Mn, Co, Ni, Al, V, Cr, Ti and the index of the disease activity. Among these elements, Se, Al, Co, Ni, V, Cr, Ti were relevant more closely, and after the analysis of stepwise regression, we knew that Fe, Mn, Co, Se, V, Pb were relevant more closely with the Kashin-Beck disease^[8].

In the study on trace elements by Xinping Xiao (1986), the amount of Se, Sr, F, Cr, Zn, Mo in the drinking water of the disease areas was lower than those in other areas; In converse, Cu, Fe, Mn were more contained; the amount of Pb was similar to the none-disease areas. The amount of Se, Sr, F in disease areas was significantly different from none-disease areas, but Cu, Se and Sr were closely related to the illness. In drinking water, if the amount of Se, Sr was low, but that of Cu was high, the illness there would be very serious; If the amount of Se was low, but the amount of Sr and Cu was high, illness there was still very serious; If the amount of either of Se and Sr was high but the amount of Cu was low, the disease incidence would be low; If both the amount of Se and Sr was high but that of Cu was low, people there would not catch the disease. This showed that three elements --- Se, Sr and Cu influenced the state of Kashin-Beck together^[7].

From the investigation in Kashin-Beck areas in Rangtang County, we mainly analyzed the relationship between the amount and the pathogen of some elements such as Fe, K, Ca, Cr, Zn, Sr, Se, Ni, U, As, Sb, Ag, La, Ce, Nd, Eu, Tb, Sm, Yb, Lu, Cs, Rb, Sc, Au, W, Br, Ba, Hf, Ta, Th, Zr and so on.

3.2 THE RELATIONSHIP BETWEEN NUTRIENT ELEMENTS IN WATER AND KASHIN-BECK DISEASE

Through analysis on the water samples in Kashin-Beck disease areas in Rangtang County, we find the main nutrient elements are Fe, Na, K, Ca, Cr, Zn, Sr, and Se.

The amount of Fe in research areas is 2.08 times as much as that in the Yangtze River, and in ZeQu River it is

3.35 times as much as that in Yangtze River, but in the basin of Duke River, it is only 0.75 times of that in Yangtze River. Cr in Yangtze River is 12.6 mg/L, and the average in research areas is 1.36 times as much as that in the Yangtze River. Compared with the Cr's 29.3mg/L in the basin of ZeQu River, 9.1 mg/L in the Duke River seems no much in amount(as Fig1、Fig2). The amount of Na and K in the basin of ZeQu River is higher than it in Duke River. But in the basin of Duke River, Ca is more contained than it in ZeQu River. Zn in the research areas is much higher contained than the background value, and in the basin of Duke River, Zn is higher in amount than it in ZeQu River. Sr in research areas is lower in amount than that the background value, and in the Duke River basin, it is more than it in ZeQu River.

Some studies show that Kashin-Beck disease may be related to the lack of Se. In some literatures we know that drinking water in Kashin-Beck disease areas is in a state of low Se nutrition. After measuring selenium contents in disease areas, Jiyun Li (1982) found that Se was low in amount both in internal and external environment and low Se in environment was obviously negative in correlation to Kashin-Beck disease. The Se level in the children who had caught this disease was much lower than that of healthy children. Qiubing Bai (1988) made multivariate statistical analysis on the data of ecological environment in different disease areas, finding that Se could be considered as an early index of illness and significantly influenced the state of the disease^[10]. Shunjiang Li, Linsheng Yang (2006) also pointed out that Se in drinking water was closely related to the state of Kashin-Beck disease and looking for drinking water with high Se should be encouraged. That, he suggested, would be an important measure to control KBD^[11]. But the result of neutron activation analysis in this area show that Se is not low in its amount in water, but even high. The average amount of the area is generally above 1mg/L, which is 11.82 times as much as in Yangtze River source, and is much higher than 0.17 mg/L in Yangtze River headwater areas. Se in Duke River basin even appears to be higher in amount than it in ZeQu River.

Se sometimes appears to be negatively related to high Se disease areas, low Se disease areas and non-disease areas with low Se, which leads to the conclusion that low Se environment is not a factor of causing Kashin-Beck disease. About the relationship between Se and Kashin-Beck disease, many scholars' opinions are consistent --- Se isn't the initial motive of KBD, but one important factor of causing it.

3.3 THE RELATIONSHIP BETWEEN TOXIC ELEMENTS IN WATER AND KASHIN-BECK DISEASE

Through the investigation on the water samples in Kashin-Beck disease areas of Rangtang County, we found

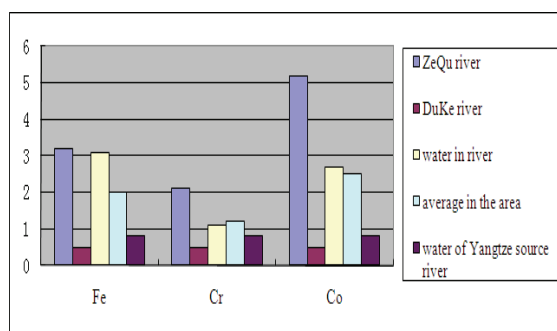


Fig 1. The Comparison to nutrition elements in different basin

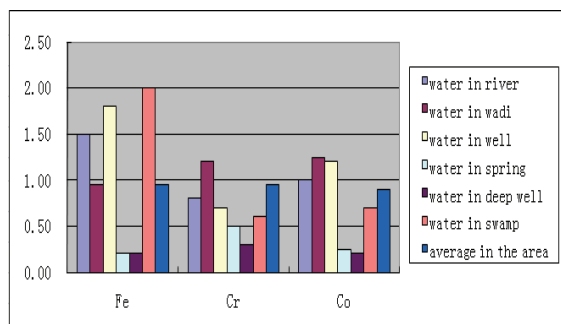


Fig 2. The Comparison to nutrition elements in different water source

toxic elements are mainly Ni, U, As, Sb, and Ag.

Generally the value of U in research areas is higher than the background value in the headwater of Yangtze River, and the amount in Duke River basin is twice as that in ZeQu River. Sb in Duke River basin is lower in amount than its background value in the headwater of Yangtze river, but in ZeQu river it is higher in amount. As and Ag have no background value in Yangtze river headwater. The amount of As in Duke River basin is lower than that in ZeQu River basin, but Ag is the opposite. Ni is far higher than that its background value in Yangtze River headwater, and in Duke river basin it is higher than that in ZeQu River basin (as Fig.3、 Fig.4) .

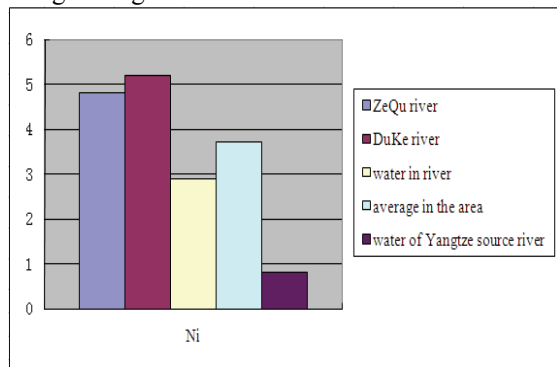


Fig 3. The Comparison to Ni elements in different basin

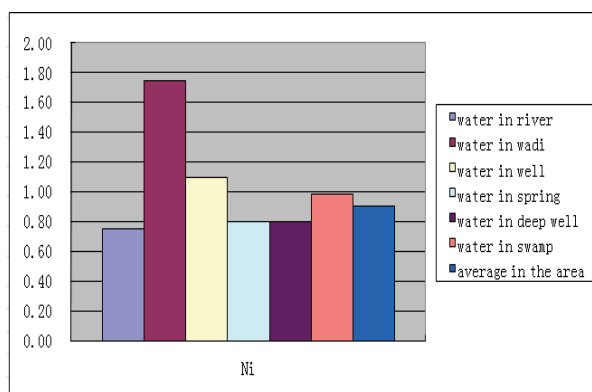


Fig 4. The Comparison to Ni elements in different water source

Afore studies showed that Ni in disease areas was significantly higher in volume than those non-disease affected areas, and U was lower than that in healthy areas. ($P < 0.05$); Sb was lower in amount than that in healthy children in these disease areas, but all kinds of toxic elements' amount were not surpass the normal amount^[12]. Also someone thought that Ni in the disease areas was significantly lower in volume than it in non-disease areas^[8].

3.4 THE RELATIONSHIP BETWEEN RARE-EARTH ELEMENTS IN WATER AND KASHIN-BECK DISEASE

Through the analysis of water samples in Kashin-Beck disease areas of Rangtang County, we find rare-earth elements are mainly La, Ce, Nd, Sm, Eu, Tb, Yb and Lu.

Generally the average amount of rare-earth elements which contain Ce, La, Nd, Sm, Yb, Eu, Tb, and Lu is higher than the background value of them in Yangtze River headwater areas, but the rare-earth elements' amount in ZeQu river basin is obviously higher than that in Duke River basin (as Fig.5、 Fig.6) .

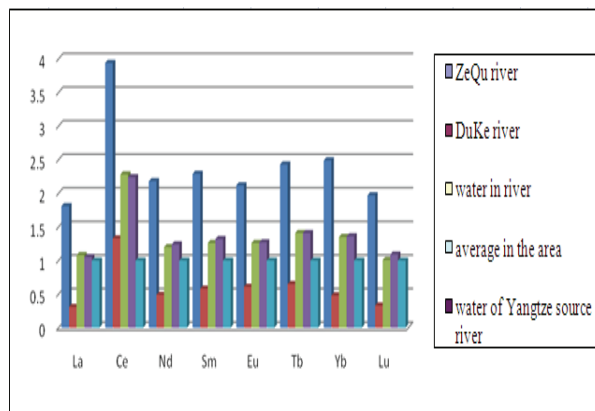


Fig 5. The Comparison to rare earth elements in different basic

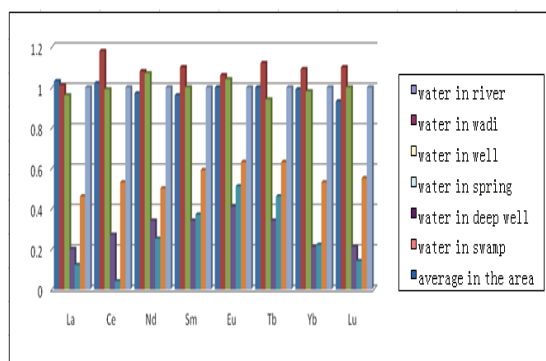


Fig 6. The Comparison to rare earth elements in different water source

3.5 THE RELATIONSHIP BETWEEN RARE ELEMENTS IN WATER AND KASHIN-BECK DISEASE

Through investigation on the water samples in Kashin-Beck disease areas of Rangtang County, we found rare elements are mainly Cs, Rb, and Sc.

Compared with the background value of Yangtze river, the average value of these three elements is lower. The lowest value of the three is in Duke River, and the number of them in ZeQu River basin is higher than that in Yangtze River (as Fig.7、Fig.8) .

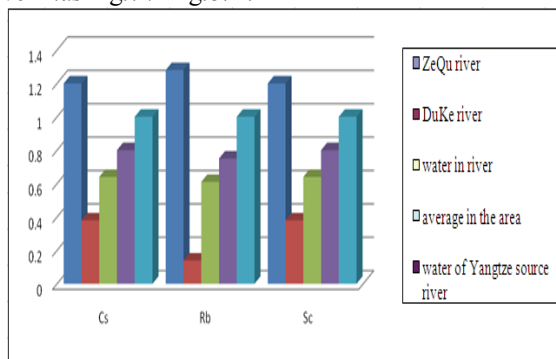


Fig 7. The Comparison to rare elements in different basin

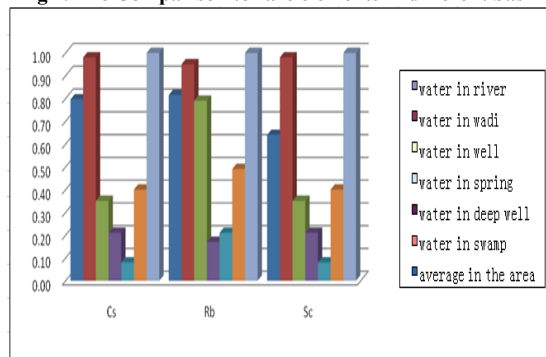


Fig 8. The Comparison to rare elements in different water source

3.6 THE RELATIONSHIP BETWEEN OTHER ELEMENTS IN WATER AND KASHIN-BECK DISEASE

Through investigation on water samples in Kashin-Beck disease areas in Rangtang County, we find other elements are mainly Au, W, Br, Ba, Hf, Ta, Th, Zr.

There is little difference between Ba in research areas and the average value of it in Yangtze River, but the difference in river basins is much higher. Ba in ZeQu River basin is significantly greater than in Duke River basin. Th in ZeQu River basin is twice as much as it in Yangtze River, and in Duke River is lower than the background value of Yangtze River headwater areas. Br, Hf, Ta also show the same characteristics. Au, W, Zr in Duke River basin are greater in volume than those in ZeQu River basin. Afore studies suggested that Zr in diseased children in disease areas was higher in amount than that in children in disease-unaffected areas^[12], and Ba in disease areas is lower than it in disease-unaffected areas^[8].

4. CONCLUSION

1. Some of the nutrient elements such as Fe, Co and Cr in drinking water in disease areas are significantly different in amount, but most studies show that Fe in the disease areas is higher than disease-unaffected areas. Na, K, and Se in serious disease areas are higher than in less serious disease areas, and Ca and Sr in Rangtang County are lower in amount than in disease unaffected areas. Afore researches showed that low Se was the main cause of the Kashin-Beck disease, which is opposite to the investigation in Rangtang County. Further researches are needed. The nutrient elements in drinking water which are closely related to the Kashin-Beck disease are mainly Fe, Sr and Se.

2. Previous researches showed the amount of some toxic elements such as Ni and Sb in drinking water is significantly different from areas to areas. But in Rangtang County, Ni in disease areas seems to be higher in amount than it in the disease-unaffected areas. Sb is the opposite case. Contrary to previous researches, U in disease areas seems to be higher than it in disease-unaffected areas; it is also higher in serious illness areas than less serious illness areas. As in serious illness areas is higher than in less serious areas, but Ag is the opposite case. Further researches are needed on the relationship between Ni, Sb and the cause of Kashin-Beck.

3. In Rangtang County, the average of some rare-earth elements in drinking water such as Ce, La, Nd, Sm, Yb, Eu, Tb, and Lu is higher than they in disease-unaffected areas, and they are obviously higher in serious illness areas than in less serious regions. The average of some rare elements in drinking water, such as Rb, Cs, and Sc is lower in amount in the disease areas than non-affected areas, but they are higher in serious illness

areas than in less serious areas. At present, there are still no obvious materials about the relationship between these elements and Kashin-Beck disease in other regions of China.

4. Previous researches showed that in Rangtang County, Zr in drinking water in disease areas was higher in amount than it in non-affected areas, but it was lower in serious illness areas than in less serious areas in Rangtang County. Further researches are needed on the relationship between Zr, Ba and the cause of Kashin-Beck disease. In Rangtang County, it seems that Br, Hf, Ta, and Th in disease areas are higher than they in unaffected areas, and they are obviously higher in serious illness areas than in less serious areas. But Au and W seem to be lower in serious illness areas. At present, there are still no obvious materials about the relationship between these elements and Kashin-Beck disease in other regions of China.

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