

Change of selenium in environment and risk of adolescent idiopathic scoliosis: a retrospective cohort study

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Abstract. – OBJECTIVES: Scoliosis is the disease which has a long history over one century. However, the pathogenesis remains unclear at present. To demonstrate the effect of different selenium content in environment on the morbidity of adolescent idiopathic scoliosis (AIS).

METHODS: Retrospective cohort study (follow-up from 1997 to 2009): compare the difference morbidity between high selenium group and the normal selenium group of AIS.

PATIENTS: 9998 cases from three areas in China were participated in this study. There is different selenium content in these three areas.

RESULTS: High selenium levels were significantly associated with the AIS morbidity. While low selenium level had no significant correlation with the AIS morbidity.

CONCLUSIONS: This study confirmed that high selenium content in the environment was one of risk factors for idiopathic scoliosis. We speculated that the excessive growth of the spine and the spinal cord asynchronous growth effect were key factors that high selenium content in the environment leads to scoliosis.

Key Words:

Selenium, Adolescent, Idiopathic scoliosis, Retrospective cohort study.

hair of scoliosis patients had been significantly decreased compared with the normals which suggested the selenium deficiency may induce the occurrence of scoliosis. Lemly⁵, an ecologist, discovered a large number of fish had scoliosis in the presence of lordosis and kyphose in the Lake of the United States which had a high selenium level due to be contaminated by thermal power station; the prevalence of deformity of the fish had positive correlation with selenium content in the lake, which also implied that high selenium level may be a risk factor for scoliosis of fish spine (Figure 1). It leads to a new problem for us whether the incidence of scoliosis of human in selenium-rich areas would change or not? Is selenium content a protective factor or a risk factor for scoliosis? What the mechanism that selenium affect spine is?

Shadi Town and Xintang Town of Enshi City in Hubei Province of China have been reported as the area which has the most widely distributed selenium and the highest selenium level by far, and the first independent selenium deposit in the world has been discovered here⁶. The inhabitants in this region had endemic selenosis in the 1950s and 1960s because they were living on wild plant due to famine and crop failure. There were 477 cases of human endemic selenosis from 1923 to 1987, and 70% patients focused on from 1959 to 1963, 90% patients distributed in Shadi, Xintang and Shuanghe of Enshi City⁷. Although selenosis has been controlled in this area, selenium per capita is still in the toxic level⁸. Luoxia Town and Hanyuan Town of Xihe County in Gansu Province are located on the Keshan disease zone⁹, which is clearly considered as a low selenium area¹⁰. Shadi Town of Enshi City is some similar with Xintang Town of Enshi City in living standard, economic level and social environment. Dongxiang County of Linxia City in Gansu Province is located in the normal

Introduction

Scoliosis is the disease which has a long history over one century. However, the pathogenesis remains unclear at present. The scope of etiology has been explored into the genetics, endocrinology, biomechanics, auxology and other related fields. There has been no theory which is convinced by the public and could explain all special symptoms of scoliosis^{1,2}. The relationship between selenium content and scoliosis has been researched less in etiology. Dastyh and Cienciala⁽³⁾, Dastyh et al⁴ proposed the selenium level in the serum and the

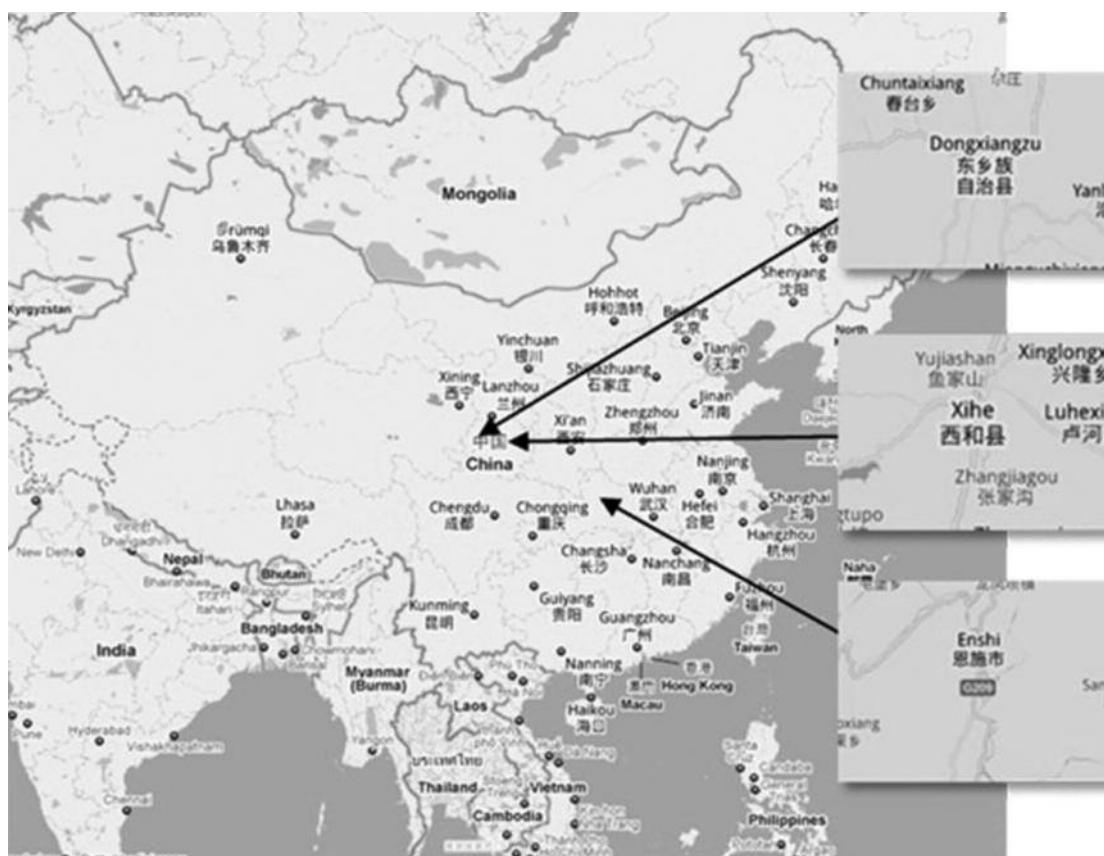


Figure 1. Distribution of survey area.

area of selenium, and never has the case of selenium deficiency or excessiveness, but its living standard, socio-economic environment are similar to the other two areas.

Lemly in his study⁵ found that increasing selenium causes spine deformity in fish by some mechanism, so we speculate high selenium may be a risk factor for ASI. But there has been no corresponding research evaluation on scoliosis from different areas with different selenium content so far. There are different selenium content in three areas that Shadi Town is of high-selenium, Xihe County is of low-selenium and Dongxiang County is of normal selenium as mentioned above. Herein high risk group of ASI (adolescent from 12 to 16) in those three areas were compared with each other in this paper.

Methods

Data Collection

The morbidity of scoliosis in China is about 1% according to previous papers¹¹, and RR is

about 2. and about 3000 people are needed to be studied in each group ($\alpha = 0.05$, $\beta = 0.10$). We selected 3463 junior school students (from 12 to 16 years old) from Shadi Town and Xintang Town of Enshi City in Hubei Province as the high-selenium group following the cluster sampling method. While the low-selenium group is of 3210 students (from 12 to 16 years old) from Luoyu Town and Hanyuan Town of Longnan City in Gansu Province. The normal control group is of 3286 persons (from 12 to 16 years old) from Suonan and Dongyuan of Linxia City in Gansu Province. All students in the research were accepted physical examination and questionnaire survey which includes gender, age, and menses for women, physical activity, dietary habit, family history. The people would accept X-ray examination for spine, whose shoulders were imbalance or who was positive object after Adams antexion test through the second physical examination. Record the angle, section, and Risser feature of scoliosis diagnosed by X-ray examination. The measurement would not be influenced by the filming of X-ray even the machines of X-ray had

Table I. The idiopathic scoliosis data of the areas with different selenium content.

Category	Objective people	Excluded people	Imbalanced shoulders	Patient	Morbidity	Average angle	Other reasons for scoliosis				
							Native	Others	Up-thoracic scoliosis	Thoracic scoliosis	Thoracic waist scoliosis
<i>Enshi group</i>	3428	35	155	56	1.60%	17	1	0	4	32	20
male	1864	23	78	36	1.90%	14	1	0	2	18	16
female	1564	12	77	20	1.20%	21	0	0	2	14	4
<i>Normal group</i>	3174	36	42	18	0.57%	24	1	0	1	11	6
male	1755	21	22	10	0.40%	17	0	0	1	2	4
female	1419	15	20	8	0.78%	33	1	0	0	9	2
<i>Ziyang group</i>	3286	39	35	14	0.43%	11	0	1	0	10	4
male	1645	14	14	6	0.36%	11	0	0	0	3	3
female	1641	25	21	8	0.49%	12	0	1	0	7	1

different types including film camera, digital radiography (DR), and computed radiography (CR). And the results were also not affected by the condition that data collection was in the remote village although shooting work was accomplished by one surveyor.

Data Analysis

Only local native born residents (removing 110 persons from 9998 persons). Thus, the final statistical database included 9888 persons (male 5264, female 4624, total 9888), of which 88 cases (0.8%, 88/9888) had AIS, 3428 (35%, 3428/9888) were exposed to a high selenium environment. There were no significant differences in age, gender, socio-economic environment among the high-selenium group, the low-selenium group and the normal control group.

The occurrence of AIS and the relative risk of different groups with the different selenium content were calculated. In order to exclude other dangerous factors, we performed the stratified analysis according to different gender and having family history or not, because there is scoliosis more common in women and the tendency of familial aggregation (Table I).

Since the information we had obtained could only determine whether there is AIS for study object, and could not make sure the specific time of the frequency of AIS, so we cannot perform survival analysis.

Results

Table I shows the situation of diseases of three groups: AIS morbidity of the high selenium group was significantly higher than that of normal selenium group. Its relative risk (RR) was 2.88, with 95% confidence interval (1.72-4.85) and the attributable risk percentage was 65.3%; there was no significant correlation about AIS morbidity between low selenium group and normal selenium group, and its relative risk (RR) was 0.75, with 95% confidence interval (0.37-1.50).

If performing stratified analysis by gender, male in high-selenium group had significantly higher prevalence than that in normal control group, and its relative risk (RR) was 3.39, with 95% confidence interval (1.68-6.82) and the attributable risk percentage was 70%. While female in high-selenium group also had remarkably higher morbidity than that in normal selenium group, and its relative risk (RR) was 2.26,

Table II. Relative risk of AIS morbidity in different areas of China with different selenium content.

Independent variable	Male			Female		
	Relative risk	95% confidence interval	Relative risk	95% confidence interval	Relative risk	95% confidence interval
Enshi: Normal	2.88	1.72-4.85	3.99	1.68-6.82	2.26	1.50-3.42
Ziyang: Normal	2.63	1.72-4.68	3.99	1.68-6.83	2.26	1.50-3.43
Enshi: Ziyang	0.75	0.37-1.50	0.64	0.23-1.73	0.86	0.32-2.29
More activity: Less activity	0.77	0.09-6.82	0.75	0.40-1.37	0.70	0.37-1.32
Meatdiet: Vegetarian diet	1.47	0.94-2.27	0.86	0.45-1.65	1.62	0.87-2.97
Family history: no family history	4.53	2.58-7.92	6.58	3.28-13.06	2.56	0.92-7.10

with 95% confidence interval (1.50-3.42) and the attributable risk percentage was 56%. So men were more vulnerable to this risk factor. The other index and their correlation with ASI were shown in the Table II.

Discussion

The results showed that there was significant correlation between high selenium and scoliosis morbidity, and scoliosis angle of female in high selenium content was larger than that of male, but the scoliosis cases of male were more than that of female (see Table I) which agreed with the rules of idiopathic scoliosis. Men were more vulnerable to this risk factor than women, but the outcome also needed to be further verified due to the fewer cases (about 1500 cases) after stratified analysis. Table II suggested that AIS morbidity of Enshi and Ziyang were more than that of normal group, but there was no significant difference between ASI morbidity of Enshi and that of Ziyang. The eating habit was set as the option which may provide a clue to the impact of nutritional status on disease in order to check whether meat diet and vegetarian diet influenced the risk of AIS, but the results were negative. The crowd of survey was divided into two groups according to the degree of physical activity (daily physical activity with more than 2 hours was more group, and less than 2 hours was less group), and the results suggested the degree of physical activity did not appear significant associated with the AIS morbidity. The children with family history were more likely suffering from AIS. 14 children whose 401 relatives had scoliosis (specific diagnosis unknown) appeared idiopathic scoliosis, and this result also needed to be further verified due to the fewer cases (401).

The epidemiological investigation confirmed high selenium content was related with idiopathic scoliosis morbidity, but the mechanism that high selenium content induced scoliosis was still unknown. We offered the following possible explanations: we speculated very high selenium level may not cause scoliosis as the symptoms of local selenium poisoning (including hair, nails falling off or nervous, blood, immune system, skin and teeth being damaged) did not include scoliosis⁽¹²⁾. However, a large number of animal experiments suggested that intaking a certain amount of selenium would significantly boost body development¹³. We supposed that this growth-promoting

effect of selenium resulted in patients' spinal overgrowth in growth cycle and it lead to scoliosis through a certain mechanism. Thus, we speculated that high-selenium level caused scoliosis through inducing spinal overgrowth and the effect of asynchronous growth. But this hypothesis was still inconsistent with some phenomena during investigation. We did not find any height differences among these three areas, and we could not explain why male was more susceptible to the effects of high selenium. We would research the change of curvature of the spine with different selenium level and its links with the growth of the spine in the further study. And observe the change of spinal curvature incidence by artificially controlling asynchronous growth in order to verify the specific mechanism of high-selenium inducing fish scoliosis which provided the clue to finding out the pathogeny of human idiopathic scoliosis.

Conclusions

This study confirmed that high selenium content in the environment was one of risk factors for idiopathic scoliosis. We speculated that the excessive growth of the spine and the spinal cord asynchronous growth effect were key factors that high selenium content in the environment lead to scoliosis.

Conflict of Interest

The Authors declare that they have no conflict of interests.

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