Investigation Report on the Effects of Selenium on Human Health in Guanzhong Area

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Abstract. 120 respondents which from selenium-rich and selenium-poor areas respectively were investigated and analyzed by means of questionnaire survey and statistical analysis to study the relationship between soil selenium level and human health in GuanZhong area, shaanxi province. Studies have shown that the incidence of diabetes ($X^2 = 4.25, P < 0.05$), coronary heart disease ($X^2 = 4.63, P < 0.05$) and gastritis ($X^2 = 6.67, P < 0.01$) in selenium-poor areas in GuanZhong area, shaanxi province is significantly higher than that in selenium-rich areas. It is urgent to adjust the dietary habits in the selenium-poor areas, and pay attention to proper intake of selenium-rich food in daily diet, so as to prevent and treat the related diseases caused by selenium deficiency.

1. Introduction  
Selenium, as one of the essential trace elements of the human body, plays an important role in regulating various physiological functions of the human body. Selenium deficiency can affect the function of important organs in the human body, leading to disease. Li et al point out soils with a soil selenium content higher than 0.2 mg • kg\textsuperscript{-1} as selenium-rich soils, and soils equal to or lower than 0.2 mg • kg\textsuperscript{-1} as selenium-depleted soils \cite{1}. Simultaneously, Ren et al found that the soil selenium content in the GuanZhong Plain of Shaanxi was between $0.034 \times 10\textsuperscript{-6}$ and $2.628 \times 10\textsuperscript{-6}$ mg • kg\textsuperscript{-1}, which had significant regional characteristics. Among them, the soil selenium content in Xi’an is between $0.3 \times 10\textsuperscript{-6}$-0.4 $\times 10\textsuperscript{-6}$ mg • kg\textsuperscript{-1}, which belongs to the selenium-rich area; the soil selenium content in the local area of Dali County, Weinan City is $<0.1 \times 10\textsuperscript{-6}$ mg • kg\textsuperscript{-1}, which belongs to the typical selenium-depleted area \cite{2}. In order to understand the relationship between soil selenium levels and human health in the GuanZhong region of Shaanxi, we selected selenium-rich regions and selenium-depleted regions as the research objects, and used a combination of questionnaire surveys and statistical analysis to understand and master selenium and certain endemic diseases in the GuanZhong region of Shaanxi. The relationship provides a reference for the treatment of human diseases caused by selenium deficiency in this area.
2. Survey objects and methods

2.1. Survey objects
The survey targets included Lintong District of Xi'an City in the selenium-rich area and Dali County of Weinan City in the selenium-free area. 120 people were selected in the selenium-enriched area and selenium-depleted area as the survey objects respectively. The survey was based on the principle of random sampling, and the proportion of men and women interviewed was close. The survey was conducted by issuing a self-made physical disease questionnaire. The questionnaire includes six items such as diabetes, coronary heart disease, hyperlipidemia, cardiovascular and cerebrovascular disease, gastritis, and osteoporosis (Table 1). A total of 240 forms were distributed and 240 forms were recovered. The filling rate of the forms was 100% efficient. The survey scope is relatively large, and it can truly reflect the relationship between selenium and human diseases in GuanZhong area of Shaanxi.

2.2. Statistical Analysis
The data was sorted by Excel 2013, and the data statistics were processed by SPSS18.0 software. $X^2$ test with $P < 0.05$ considered significant.

3. Results and analysis
Data were tested by $X^2$ after the survey, the results showed that the incidence of diabetes ($X^2 = 4.25, P < 0.05$), coronary heart disease ($X^2 = 4.63, P < 0.05$), and gastritis ($X^2 = 6.67, P < 0.01$) was significantly higher in the selenium-rich areas. In selenium-poor areas, Hyperlipidemia ($X^2 = 0.87, P > 0.05$), cardiovascular disease ($X^2 = 0.24, P > 0.05$), and osteoporosis ($X^2 = 1.92, P > 0.05$) did not exist between selenium-rich and selenium-depleted areas. The difference in biostatistics shows that the incidence of three diseases in selenium-rich areas is lower than that in selenium-depleted areas.

### Table 1. Disease characteristics of the respondents

| Diseases          | area    | Disease-free (No.) | Sick (No.) | Total (No.) | Disease percentage (%) | $X^2$  | $P$       |
|-------------------|---------|--------------------|------------|-------------|------------------------|--------|-----------|
| Diabetes          | Lintong | 109                | 11         | 120         | 9.17                   | 4.25   | <0.05*    |
|                   | Dali    | 98                 | 22         | 120         | 18.33                  |        |           |
| Coronary heart disease | Lintong | 113                | 7          | 120         | 5.83                   | 4.63   | <0.05*    |
|                   | Dali    | 103                | 17         | 120         | 14.17                  |        |           |
| Hyperlipidemia    | Lintong | 106                | 14         | 120         | 11.67                  | 0.87   | >0.05     |
|                   | Dali    | 101                | 19         | 120         | 15.83                  |        |           |
| Cardiovascular Disease | Lintong | 112                | 8          | 120         | 6.67                   | 0.24   | >0.05     |
|                   | Dali    | 110                | 10         | 120         | 8.33                   |        |           |
| Gastritis         | Lintong | 114                | 6          | 120         | 5.00                   | 6.67   | <0.01*    |
|                   | Dali    | 102                | 18         | 120         | 15.00                  |        |           |
| Osteoporosis      | Lintong | 109                | 11         | 120         | 9.17                   | 1.92   | >0.05     |
|                   | Dali    | 102                | 18         | 120         | 15.00                  |        |           |

4. Discussion and conclusion
Selenium plays an important role in the normal development of the human body. China is a typical selenium-deficient region. The relationship between selenium and human health in China is mainly manifested in the body's health or sub-health status caused by selenium deficiency due to insufficient selenium intake [3]. This study found that the incidence of diabetes, coronary heart disease, hyperlipidemia, cardio-cerebral vascular disease, gastritis, and osteoporosis in the GuanZhong region of Shaanxi has a negative correlation with natural selenium content. Among them, the incidence of diabetes, coronary heart disease, and gastritis in selenium-rich areas is significant. It is lower than that in selenium-deficient areas, and the incidence of hyperlipidemia, cardiovascular and cerebrovascular diseases, and osteoporosis also shows a high level in selenium-deficient areas, which is consistent with previous research results [4-5].
History of diabetes is one of the "three high" diseases common in China. Selenium compounds as insulin medicinal molecules can lower blood sugar levels. When Hwang studying whether selenium treatment is beneficial for patients with diabetes, found that selenium treatment can reduce the blood glucose level of diabetic mice, the study also found that the serum components related to liver injury in the body of mice treated with selenium also decreased significantly [6]. The selenium-containing antioxidant enzymes in myocardial tissues are involved in removing H2O2 from human myocardial cells, thereby protecting the normal functions of myocardial cell membranes and mitochondria and other organelles [7]. The blood selenium level of patients with coronary heart disease in China is also lower than the normal population, which is consistent with the findings of this article. A large number of studies have shown that the incidence of various heart diseases and human blood selenium levels are significantly negative. The serum selenium content is less than 4ug • L−1 month. The incidence of cardiovascular disease is 2-3 times higher than the normal population [8]. In addition, selenium was significantly negatively correlated with the incidence of various human cancers. Studies have shown that selenium-rich drugs can inhibit carcinogen-induced formation of DNA covalent compounds, DNA oxidative damage, and DNA methylation, inhibit micronuclei formation and chromosomal aberrations in the body, and prevent cell cancer from deteriorating [9].

In conclusion, the survey found that soil selenium levels in the GuanZhong region of Shaanxi were negatively correlated with the incidence of human diabetes including coronary heart disease, diabetes and gastritis. Selenium-poor areas urgently need to carry out publicity and education on selenium culture, urge the masses to adjust dietary habits reasonably, and supplement selenium in an appropriate amount, in order to prevent and treat selenium deficiency-related diseases.

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References
[1] Li J X, Zhang G D, Ge X L, et al. Geochemical environmental characteristics and prediction of human selenium deficiency and excess[M]. 2000, Beijing: Geological Publishing House.
[2] Ren R, Wang M X, Chen J P, et al. Distribution characteristics and influence factors of soil selenium in GuanZhong area, Shaanxi [J]. Mineral Resources Exploration, 2018, 9 (09): 201-207.
[3] Xia Y M, KEHill, Li P, et al. Study on selenium requirements of Chinese adults [J]. Acta Nutrimenta Sinica, 2011, 33(2): 109-113.
[4] Bleys J, Navas-Alcien Laclaustra M, et al. Serum selenium and peripheral arterial disease: Results from the national health and nutrition examination smev, 2003-2004 [J]. Am. J. Epidemiol., 2009, 169: 996-1003.
[5] Guan Y Q, Zhu L, Wang C, et al. Selenium and human health [J]. Modern Preventive Medicine, 2003, 30 (5): 700-702.
[6] Daeyoun H, Sujin Seo, Yongkyu Kim. Selenium acts as an insulin-like molecule for the downregulation of diabetic symptoms via endoplasmic reticulum stress and insulin signalling proteins in diabetes-induced non-obese diabetic mice [J]. Journal of Biosciences, 2007, 32(4): 723-735.
[7] Yang Y X, Shao X. Biological trace element selenium and human health [J]. Journal of LiaoCheng University (Natural Science Edition), 2002, 15 (1): 60-62.
[8] Pan X Q, Wei J, Wang R, et al. Effects of low selenium on cardiac function and myocardial mitochondrial ultrastructure in rats [J]. Chinese Journal of Endemiology, 2013, 32 (4): 378-383.
[9] Yang C Y, Li G C, Song D, et al. Current status and prospects of drug treatment related to DNA methylation / demethylation [J]. Life Science, 2018, 229 (4): 45-52.