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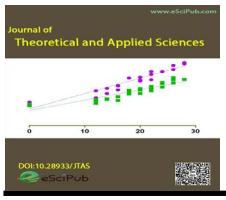

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Relationship between regional longevity and elements in environmental media in China

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ABSTRACT

Longevity has always been a desire and expectation since ancient times. Exploring the influencing factors of longevity is the goal of many scholars. Longevity has spatial aggregation. The influence of natural geographical environment on longevity is the focus of research. The content and distribution of elements in environmental media are one of the important factors affecting longevity. At present, there is still a lack of systematic exposition of regional health and longevity, and a lack of overall grasp of the relationship between elements in environmental media and health and longevity. Based on the research of environmental elements and longevity in typical longevity areas, this paper explores the key dominant elements affecting longevity and provides scientific basis for improving the health level of the elderly population.

Keywords: Health and longevity; Environmental medium; Element

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1. Preface

Healthy longevity is an important symbol of social progress and civilization development in a region. It has always been the expectation and vision of human beings. Therefore, the factors related to longevity have received extensive attention. The United Nations stipulates that the standard of longevity areas is that there are more than 75 centenarians per million people. [1] At present, the world 's five largest longevity towns are Bama in Guangxi, Hotan in Xinjiang, Hansa in Pakistan, Bikalbamba in Ecuador and Transcaucasia[2]. The reasons affecting longevity are complex and changeable. In order to explore the reasons for the large population of centenarians in longevity areas, different experts analyze the factors affecting longevity from different perspectives. Social and cultural aspects, such as the external environment[3-4], genetic[5-9], psychological[10], nutritional diet[11] and other factors will directly or indirectly affect human life ; from the aspect of natural environment, the aggregation of longevity population proves that the influence of environmental factors on longevity is beyond doubt. The impact of the natural environment on longevity has led experts to analyze it from different perspectives, such as climate[12-13], geomagnetic field[14], topography[15], air pollution[16], solar radiation[17] and other reasons. Studies have shown that geochemical reference values are positively correlated with blood element content, and elements on Earth are closely related to life composition and health.[18] Lar and Uriah Alexander [19] studied the connection between trace elements in Nigeria 's crust and soil and water, and preliminarily analyzed their effects on human health. The correlation between them is very large, the influence of elements in the environment on the human body is very important.

Elements in environmental media are important substances to maintain the normal physiological needs and physiological functions of all organisms, and play an important role in human life [20]. In particular, the concentration level and combination characteristics of elements are one of the important factors affecting human life[21]. Many scholars have explored the relationship between elements in environmental media and longevity, and there is a certain correlation. Vines [22] took animals as the research object and confirmed that the superior trace element spectrum can prolong the average life expectancy by 28.5 % to 78.2 %. Therefore, it is of great theoretical and practical significance to compare and analyze the elements in the living environment of longevity areas and non-longevity areas and explore their regional differences. However, at present, all scholars only analyze a certain longevity area. This study analyzes and sorts out the research results to find the dominant elements of human health and longevity and provide reference for future research.

2. Distribution characteristics of longevity regions

China 's population is unevenly distributed with more in the east and less in the west. There are also regional differences in the distribution of longevity population, that is, regional longevity-the longevity level of a certain area at a certain time point or a period of time is significantly higher than that of the surrounding areas, and its longevity level is also among the best in the country. For example, Bama, Rugao and other places in Guangxi were first called " the hometown of longevity in the world. "

The geographical distribution pattern of longevity is extremely uneven. For example, the

differences between provinces, municipalities, autonomous regions and cities and counties in China are obvious. The results of the sixth national census show that longevity mainly occurs in coastal areas (Liaoning, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, Guangxi and Nanning), central and western regions (Henan, Anhui, Hubei, Hunan, Guizhou, Chongqing and Sichuan) and Xinjiang Uygur Autonomous Region. By comparing longevity indicators, the degree of longevity in China clearly reflects regional differences at the provincial level. Yang Ren [25] and others made an overall spatial analysis of the longevity characteristics of China. By counting the population age information of China, it was found that the distribution range of China 's longevity index in counties accounted for 1.3 % ~ 16.3 %, and the difference was obvious. In 92.1 % of the counties, the longevity index of women was higher than that of men. In Hainan Province, Wenchang County, Chengmai County, Lingao County and Wanning County residents live longer than other counties, the largest gap is about 15 times. [26] Pu Haixia et al [27] calculated the life index of 10 counties in Guangdong Province. The results showed that the life degree of Yangdong, Yangjiang, Jiaoling and Sanshui was higher than that of other regions. There are also significant regional differences in the longevity of the Xinjiang Uygur Autonomous Region. The longevity index in the south (especially Khotan) is higher than that in the north. [28] Bama County in Guangxi is a famous longevity area in the world, and the proportion of centenarians is higher than that in its surrounding areas. The longevity distribution of another typical longevity area - Rugao, Jiangsu Province [31-32] shows a trend of increasing from southwest to northeast. The longevity level of Shandong Province has a high level of longevity under different terrain conditions. Qingdao, Yantai and other places along the coast, Linyi in the mountainous terrain of central and southern Shandong and Heze in the plain area all have longevity [33].

The distribution of longevity areas in China is relatively scattered, and regional longevity will appear in smaller units, so it is necessary to explore the aggregation of longevity.

3. Study of elements on longevity in different environmental media

Soil, drinking water and crops in longevity areas of China are rich in life dynamic element groups. There is a superior trace element spectrum in the natural environment and the human body. These trace elements maintain the balance and physiological functions of the human body. They are one of the material bases for the health and longevity of the elderly. [43] Using animals as the research object, it was confirmed that the superior trace element spectrum can extend the life expectancy by 28.5 % ~ 78.2 % on average. The elements in the environment are closely related to the elements in the human body. Most of the elements in the human body are ingested from the outside world, such as water and food, which enter the human body directly or indirectly [34]. People's bodies are rich in various elements and coexist. Maintaining people 's healthy survival is a key factor in determining health and an important factor affecting longevity. The content of elements in different environmental media is different, and the impact on human longevity is also directly or indirectly different.

Experts and scholars have done a lot of research on the relationship between element content and longevity, and analyzed different elements from different aspects such as water, soil and crops.

Table 1 Trace elements in environmental media in long-lived area

region of interest	research aim	element	reference
Rugao, Jiangsu	drinking groundwater	Ca、Mg、SO_4^{2-}、Sr、B	Peng et al. [35]
Rugao, Jiangsu	soil	B、Se、Zn	Yang et al. [36]
Rugao, Jiangsu	Soil, shallow groundwater, atmospheric dry and wet deposition	Se、I、Zn（As、Hg、Cd、Pb）	Weng et al. [37]
Rugao, Jiangsu	Soil, food, vegetables, hair	Zn、Se（Pb、Cd、As）	Chen et al. [38]
Xinjiang Uygur Autonomous Region	natural water	TH、Mg/Ca	Liu et al. [39]
Hetian, Xinjiang	serum	Pb、Co、Cu、Zn、Mn、Fe、Se、As	Jahan et al. [40]
Guilin, Guangxi	Rock, soil, drinking water, crops, pork, hair	Se、Ca、Mn	Shao [41]
Bama, Guangxi	Nails, drinking water, daily intake	Sr、Mn、Ni、Co、Se、Fe	Cai [42]
Bama, Guangxi	soil, water	Na、Li、Mg、Mn、Fe、V（Ca、Zn、Co、Hg）	Zhang et al. [43]
Bama, Guangxi	Staple food crops	Zn、K、Mn、P（Al、Cd、Co、Pb）	Zeng et al. [44]
Bama, Guangxi	Water, soil, food	Se、Mo、Ni、Zn、Fe、Li、Sr、Co、Cr、Ca	Li et al. [45]
Yongfu, Guangxi	urine	Cr、Mn、Cu、Zn、Tl	Li et al. [46]
Hechi, Guangxi	Drinking water, soil	H_2SiO_3、Ca、Fe、Na、Mg、(Pb、Cd)	Deng et al. [16]
xijiang river basin of guangxi	Drinking water, soil	Pb	Zhang et al. [47]
Henan, Hubei, Hunan	hair	Ba、Cu、Se、Sr、Zn、(Al、Cd、Cr、Fe、Mo、Pb)	Li et al. [48]
Mayang, Hunan	soil	Cl^-、F^-、NO_3^-、Se、Cd、Hg、As、V、K、Na、Mg、Mo	Lin et al. [49]
Guangdong	staple food, soil, water	Se、K、Mo、Ni、Zn	Pu et al. [50]

province			
Zhongxiang, Hubei	staple food, drinking water, air quality	Sr、Ca、Al、Mo、Se、Fe、Mn、Zn、Cr、P、Mg、K、(Cu、Ba)	Lv et al. [51]
Zhongxiang, Hubei	Drinking water, soil, grain and oil, vegetables	Sr、Se、Li、Ca、Na、Mg、P、V、Mo、Cu、Fe、Zn、Mn	Luo et al. [52]
Xiayi, Henan	soil	Cr、Zn、K、Mg	Zou et al. [53]

Table 2 Trace elements in environmental media in long-lived area

region of interest	research aim	element	reference
Jiangjin, Chongqing	drinking water	TH、Sr、Ba、Li、Mn、Ni、Se	Liu et al. [54]
Duzhou Town and Jiangnan Town, Chongqing	surface soil	Se	Gong et al. [55]
Mengshan, Shandong	drinking water	Fe、As、Hg、Cd、Cr、Se、Sr	Yao [56]
jining Shandong	Main grains, drinking water, soil	Na、Li、Cu、Zn、Mg、Co、Cu、Mn、Sr	Wang et al. [57]
Shandong	Drinking water, diet	Se、Sr、pH、Na、Cu、Mn、P	Liu et al. [58]
Changqing, Shandong	Drinking water, environmental ecological substances	H_2SiO_3、Se	Li et al. [59]
Zichuan, Shandong	Soil, food	Se	Zhai et al. [60]
Gaomi, Shandong	groundwater	F、Na、Ca、Mg、pH	Han et al. [61]
Guanzhong plain	groundwater	As、F-、Cr^{6+}、NO^{3-}	Gao et al. [62]
Shanxi province	soil	I、Al、F、Mn、Zn、Fe	Niu [63]
xi'an, Shaanxi	serum	Zn、Fe、Ca、Mg、Pb、Cu、Cd	Han et al.[64]
Chengmai, of Hainan	Drinking water, staple food, soil, hair	Cr、Mn、Zn、Cu、Fe、Sr、Ni、F	Wang [65]
Nanshan Changshou District, Hainan	soil	Mn、Fe（V、Cr、Co、Ni、Cu、Zn、Se、Mo）	Ding et al. [66]

Songhua river basin	Soil, rice	Hg、As	He [67]
Heilongjiang	Soil, crops	Se	Liang et al. [68]
Yunnan bai nationality	Rocks, soil, springs, nuts, vegetables, pork	Ca、Mg、P、S、Zn、Fe、Se	Chen et al. [69-72]
Tuorong, Fujian	soil	Se、Zn、Mo	Xu [73]

Table 1 and Table 2 summarize the studies on elements in different environmental media and human bodies in typical longevity areas in China, indicating that the effects of elements in different longevity areas in China on longevity are consistent. At present, China 's research on elements in environmental media mainly focuses on soil, staple food crops and water. Crops and water are elements directly ingested by the human body, and soil is the medium connecting crops and water. Exploring the relationship and influence of elements in the three and longevity can effectively judge the elements that are beneficial to longevity. Some scholars have assumed that the premise of longevity is to maintain health for the vast majority of life, delay or avoid fatal diseases during aging. [74] In other words, both positive and negative factors can influence and ultimately determine whether humans live long enough. After a variety of summary found that such as Pb, Hg, As, Cr and other elements are regarded as potentially harmful elements, the impact on human life is huge, and Ca, Mg, Mo, Se, Fe and other beneficial elements is a positive impact on human life.

Appropriate and sufficient element content in environmental media is conducive to human health and longevity, while excessive or insufficient element content is harmful to human health, thus becoming an obstacle to longevity. It is reported that excessive arsenic concentration in drinking water and coal can lead to endemic arsenic poisoning [75-76]. The terrible symptoms of Minamata disease in Kyushu, Japan are caused by high concentrations of mercury (MeHg) in environmental media (water and food) contaminated by local sewage discharge [77]. Arsenic and mercury are highly toxic products, and long-term exposure will cause immeasurable harm to the human body. Insufficient selenium intake caused by extremely low selenium concentration in grains and soils is considered to be a trigger for Keshan disease and Kashin-Beck disease [78-79]. However, excessive high concentrations of selenium in environmental media can lead to endemic selenium poisoning, which can cause symptoms such as edema, limb numbness, hair loss and spasm. [80] Deng [16] reported that the longevity of Hechi City in China may be attributed to good water quality, high concentrations of Si, Ca, Fe, Na, Mg in drinking water, and lack of Pb and Cr. Cr is an essential element of the human body, but due to the different valence states, the effects on the human body are not the same. Trivalent chromium is not harmful to human health, while hexavalent chromium has certain toxicity, ranging from dermatitis and eczema to life [81]. Therefore, the valence state should be determined when studying the effect of Cr on the human body. Shao [41] found that the longevity population in Yongfu County of Guilin City may be related to the moderate selenium

intake and high calcium and manganese intake in the soil. Many studies have shown that high manganese intake is a major feature of longevity areas. Mn can promote the growth and development of bone, maintain normal brain function, maintain normal glucose metabolism and fat metabolism, and improve the hematopoietic function of the body [82]. Huang et al. [12] found that the proportion of super-aged population in Rugao County was positively correlated with the content of Se, Ni and Mo in local soil. Selenium plays an important role in the prevention of cell degeneration [83], cardiovascular disease [84] and cancer [85]. Some epidemiological studies have shown that intake of sufficient selenium can effectively reduce the incidence of various cancers [86]. In addition, selenium has antagonistic effects on harmful heavy metals and metalloids such as cadmium, lead, mercury and arsenic [87]. In summary, elements in environmental media have dual biological effects. Extremely high or extremely low levels may lead to poisoning or disease, while appropriate levels are beneficial to health and longevity, which can affect the health and longevity of local residents through long-term exposure and dietary intake.

Through the analysis of previous studies, the relevant elements affecting longevity are found to provide some reference for future research, but some problems are still found. 1 There are some differences in the dominant elements affecting longevity in different regions. The current study lacks the study of the changes in the time series of the same study area. Exploring the comparison between the changes in element content and the changes in life indicators can more accurately find the dominant elements affecting longevity. The study of sampling points in the longevity area is relatively scattered, which has certain obstacles to determine the range of dominant elements in the area. The analysis of China 's longevity area is still not comprehensive, and there is a lack of overall analysis. In summary, there is a certain relationship between the elements in the environmental medium and the longevity population, but the range of elements in the longevity area, the correlation between elements and longevity, and the accurate map of dominant elements need further exploration and research.

Conclusion

(1) The distribution of longevity population in China is not uniform. There are longevity areas in provinces, cities, counties and townships, and the degree of longevity is different. The distribution of longevity is not the same in different geographical environments.

(2) elements have a dual effect on the human body. The essential elements related to longevity are generally higher than those in non-longevity areas in a reasonable range, and the harmful elements are lower than those in non-longevity areas.

(3) At present, the research on longevity focuses on soil, water, crops and other environmental media, and there are few studies on other environmental media. The research is roughly that the differential elements obtained by comparing the longevity area with the non-longevity area are determined as the dominant elements. There are some limitations in the research. In order to determine the elements that affect longevity accurately, it is necessary to increase the research on longevity area, and to carry out the next research on rows.

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