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Geographical distribution of reference value of aging people's left ventricular end systolic diameter based on the support vector regression

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ABSTRACT

Aim: The aim of this paper is to analyze the geographical distribution of reference value of aging people's left ventricular end systolic diameter (LVDs), and to provide a scientific basis for clinical examination.
Methods: The study is focus on the relationship between reference value of left ventricular end systolic diameter of aging people and 14 geographical factors, selecting 2495 samples of left ventricular end systolic diameter (LVDs) of aging people in 71 units of China, in which including 1620 men and 875 women. By using the Moran's I index to make sure the relationship between the reference values and spatial geographical factors, extracting 5 geographical factors which have significant correlation with left ventricular end systolic diameter for building the support vector regression, detecting by the method of paired sample t test to make sure the consistency between predicted and measured values, finally, makes the distribution map through the disjunctive kriging interpolation method and fits the three-dimensional trend of normal reference value.
Results: It is found that the correlation between the extracted geographical factors and the reference value of left ventricular end systolic diameter is quite significant, the 5 indexes respectively are latitude, annual mean air temperature, annual mean relative humidity, annual precipitation amount, annual range of air temperature, the predicted values and the observed ones are in good conformity, there is no significant difference at 95% degree of confidence. The overall trend of predicted values increases from west to east, increases first and then decreases from north to south.
Conclusion: If geographical values are obtained in one region, the reference value of left ventricular end systolic diameter of aging people in this region can be obtained by using the support vector regression model. It could be more scientific to formulate the different distributions on the basis of synthesizing the physiological and the geographical factors. Highlights: -Use Moran's index to analyze the spatial correlation. -Choose support vector machine to build model that overcome complexity of variables. -Test normal distribution of predicted data to guarantee the interpolation results. -Through trend analysis to explain the changes of reference value clearly.

1. Introduction

In the background of global environmental change, the relationship between healthy body's internal environment and geographical environment has become a common concern (Yang, 2010). Human beings get the environmental adaptability of temperature, humidity and so on in order to maintain its normal body's function, it is called the process of acclimation. Heart as the power source of the human circulatory system, the functional parameters have their different responses under the different environmental stresses (Lewis and Phillips, 2012).

Left ventricular end systolic diameter is the internal diameter of left ventricular when the left ventricular systolic achieves to the minimum, it is an important index to measure the systolic function of the heart. At present, the lack of the unified standard of reference values of left ventricular end systolic diameter influences the effectiveness of clinical diagnosis, some medical workers in the region measure the reference values of left ventricular end systolic diameter, but without taking the consideration of the influence of geographical factors (Wang, 1989). The series research results by our scientific research team (Ge, 2006; Ge et al., 2009, 2010, 2013; He et al., 2007; Yan et al., 2009; Yang et al., 2013) show that there is a close relationship between geographical factors and people's health indexes, integrating the effectiveness of geographical factors could adapt to the need of clinical diagnosis better and scientifically.

2. Materials

2.1. The geographical factors

The ancient Greek doctor Hippocrates discussed through the air, water, soil and other natural environment factors on human health in

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the 4th century BC, as early as the Ming Dynasty of China, Li Shizhen also stressed in his famous book *Compendium of Materia Medica* that water was the source, soil was the mother of all things, its our health's lifeblood (Lin, 1980), modern geography research also had been recognized that geographical factors are very important, sometimes play a decisive role in human health, such as the climate, soil, bedrock (Stevenson and Stevenson, 1990). Selinus O. who is the president of International Medical Geology in his latest book *Medical Geology* explained that geology looked far from our health, but most of the geological elements through the food, water and air into the body affected the body. Considering the above factors, this paper selects three kinds of geographical factors including topographic index, climate index and soil index.

2.1.1. Topographic index

Topographic index including three sub-indexes, the longitude (X_1), which means the west's or east's degree of the prime meridian in south and north directions, the unit of measure is degree (°), the latitude (X_2), which means one point and earth center's connection intersects the equatorial plane to form a line angle, the unit of measure is degree (°), and the altitude (X_3), which means one point is higher than the mean sea level, the unit of measure is meter (m).

2.1.2. Climate index

Climate index including six sub-indexes, the annual sunshine duration (X_4), which means the quantity of the observed sunshine hours in one year, the unit of measure is hour (h), annual mean air temperature (X_5), which means the average temperature of observed values for a year, the unit of measure is centigrade (°C), annual mean relative humidity (X_6), which means the average value of the percentage of air vapor pressure of saturated vapor pressure, the unit of measure is percentage (%), annual precipitation amount (X_7), which means the amount by adding a calculation of daily total precipitation for a year, the unit of measure is millimeter (mm), annual range of air temperature (X_8), which means the mean temperature of the warmest month and the coldest month in a year, the unit of measure is centigrade (°C), and annual mean wind speed (X_9), which means the average value of air moves in unit time in a year, the unit of measure is meter per second (m/s).

2.1.3. Soil index

Soil index including five sub-indexes, the topsoil organic carbon (X_{10}), which means the per unit volume contains the number of organic compounds, usually uses weight percentage of organic compounds of dry soil, the unit of measure is percentage (%), the topsoil pH (X_{11}), which means the number of hydrogen ions in the soil of the total amount of substance, the topsoil cation exchange capacity in clay (X_{12}), which means per kilogram of clay contains all the exchangeable cation, the unit of measure is centi-mol per kilogram (cmol/kg), often abbreviated as topsoil CEC (clay), the topsoil cation exchange capacity in silt (X_{13}), which means per kilogram of silt contains all the exchangeable cations, the unit of measure is centi-mol per kilogram (cmol/kg), often abbreviated as Topsoil CEC (silt), and the topsoil salinity (X_{14}), which means per unit soil contains the salt content, often uses the conductance value of 25 °C (Gao et al., 2003), the unit of measure is dS/m.

2.2. The reference values of left ventricular end systolic diameter

The reference values of left ventricular end systolic diameter of healthy aging people are collected from 71 units including research institutions, hospitals, and universities in China. According to the age criteria of *World Health Organization of the United Nations*, younger than 18 years old is juvenile, from 18 to 44 years old is young age people, from 45 to 59 years old is middle age people, from 60 to 74 years old is young elderly people, from 75 to 89 is old people, and above the age of 90 is longevous people, selecting the normal reference values of 2495 healthy aging people from 60 to 90 as the research data, in which including 1620 men and 875 women (Table 1), the aging people who have already excluded the diseases that impact the function of left ventricular such as hypertension, coronary heart disease, diabetes, arrhythmia, heart failure, rheumatic heart disease, congenital heart disease, cardiomyopathy and so on. The aging people have also no past medical histories. There is no statistics of men and women respective of the reference values, so the research without taking the gender difference into consideration, analyzed the aging people as a unified whole, the measured unit of left ventricular end systolic diameter is millimeter (mm).

Table 1
Sex and age of healthy aging people.

Group	Total	Men/women	Age
Healthy aging people	2495	1620/875	60–90

3. Methods and analysis

3.1. Spatial autocorrelation

Spatial autocorrelation analysis is a method to determine the spatial dependence of the data, it could describe the data distribution in the whole region (Griffith, 1987; Moran, 1984), spatial autocorrelation analysis commonly uses Moran's I index and Geary's C index to explain the space relations, the study chooses to calculate the Moran's I index to measure the correlation of the same variables in different space positions, by standardizing statistic Z value to determine the spatial autocorrelation relationship, under the confidence level of 0.05, $|Z| = 1.96$, under the confidence level of 0.01, $|Z| = 2.54$, taking $|Z| > 1.96$ or $|Z| > 2.54$ which can represent the region's spatial autocorrelation is significant, on the contrary, the data follow the random distribution (Wang et al., 2010).

By the calculation data (Table 2), at the confidence level of 0.01, $|Z| = 3.3279 > 2.54$, the spatial autocorrelation of the reference value of left ventricular end systolic diameter is significant, which does not follow the random distribution. Therefore, the space geographical environment has an effect on left ventricular end systolic diameter, different geographical factors make the different geographical distributions of left ventricular end systolic diameter.

3.2. Correlation analysis

By using the method of single correlation (Yu et al., 2007) between the reference values of left ventricular end systolic diameter and the 14 geographical factors, longitude (X_1), latitude (X_2), altitude (X_3), annual unshine duration (X_4), annual mean air temperature (X_5), annual mean relative humidity (X_6), annual precipitation amount (X_7), annual range of air temperature (X_8), annual mean wind speed (X_9), topsoil organic carbon (X_{10}), the topsoil pH (X_{11}), topsoil cation exchange capacity in clay (X_{12}), topsoil cation exchange capacity in silt (X_{13}), and topsoil salinity (X_{14}), calculating the correlation coefficients (Table 3), the results showed that 5 geographical factors have significant correlation with left ventricular end systolic diameter in the selected 14 geographical factors, respectively, latitude (X_2), mean air temperature (X_5), annual mean relative humidity (X_6), annual precipitation amount (X_7), and annual range of air temperature (X_8).

Table 2
Global Moran index report.

Moran's I	Mean	SD	Z-value	P-value
0.0248	−0.0152	0.0120	3.3279	0.0100