

ORIGINAL CONTRIBUTION

Normal Reference Value of Hemoglobin of Middleaged Women and Altitude

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Aim: In order to supply a scientific basis for uniting the normal reference value standard of hemoglobin of Chinese middlescent women. **Methods:** A research is made about the relationship between the normal reference value of 25,917 examples of hemoglobin of middlescent women and altitude in 268 areas in China, the normal reference values of hemoglobin of middlescent women are determined by the hemoglobincyanide method. **Results:** The correlation between the normal reference value of hemoglobin of middlescent women and altitude is quite significant ($r = 0.827$). By using the method of univariate linear regression analysis, one regression equation is inferred. **Conclusion:** If the altitude values are obtained in some areas, the normal reference value of hemoglobin of middlescent women of this area can be reckoned by using the regression equation. Furthermore, depending on the altitude, China can be divided into three districts: Qingzang District, Central District, and Eastern District.

INTRODUCTION

Hemoglobin is an important index of hematology. At present, it is difficult to achieve accuracy in clinical practice, because of the lack of a unified standard of the normal reference value of hemoglobin of middlescent women in China. Many researchers have measured the normal reference value of local hemoglobin of middlescent women [1-86]. No reports on the relationship between the normal reference value of hemoglobin of middlescent women and altitude have been found. By means of correlation and univariate linear

regression analysis, research on the relationship between the normal reference value of hemoglobin of middlescent women and altitude has shown that there are certain regular patterns between the normal reference value of hemoglobin of middlescent women and altitude.

MATERIALS

The normal reference value of hemoglobin of middlescent women

The normal reference values of hemoglobin of healthy middlescent women

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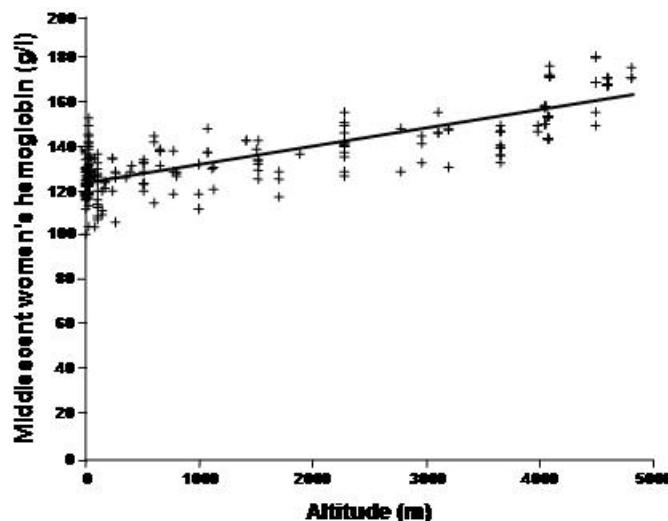


Figure 1. The regressive map of the normal reference value of hemoglobin of middle-aged women to altitude.

from various administrative units (hospitals, research institutes, and universities) have been collected in China. They include the normal reference values of hemoglobin of 25,917 middle-aged women tested in 268 units. The ages of the volunteers ranged from 26 to 45 years old. It is a mean value of hemoglobin of middle-aged women in each area, and 50 to 210 random samples were studied in every area. The determination of the normal reference value of hemoglobin of middle-aged women is performed according to the hemoglobincyanide method [87]. In this routine method: first, add 20 μ l whole blood into 5 ml HiCN reagent; next, mix the two kinds of liquid completely and rest the mixture standing for 5 minutes; then, use a spectrophotometer that has been zeroed with HiCN reagent at a wavelength of 540 nanometers and a light path of 1.0 centimeter to determine absorbency; and last, use the concerned formula to calculate the hemoglobin. The normal reference values of hemoglobin of middle-aged women are expressed in g/l.

Altitude

Altitude figures come from relevant geographical works and dictionaries [88-89]. The altitude is the height above sea level, and its unit is meter (m).

REGRESSION ANALYSIS

Correlation analysis

By using the method of mathematical correlation analysis [90], single correlation coefficients between the normal reference value of hemoglobin of middle-aged women and the altitude can be calculated: $r = 0.827$. Degrees of freedom $N - 2 = 268 - 2 = 266$, critical value of correlation coefficient is obtained from tables: $r_{0.01} = 0.159$. If $|r|$ is higher than 0.159, it means the correlation is quite significant.

Regression equation

By using the method of univariate linear regression analysis, one regression equation is inferred according to the nor-

mal reference value of hemoglobin of middlescent women and altitude (Figure 1).

$$\hat{Y} = 125.5 + 0.008057X \pm 18.5$$

In the above equation, \hat{Y} is the normal reference value of hemoglobin in of middlescent women (g/l); X is the altitude (m); 18.5 is the value of the 1.96 residual standard deviations [91].

DISCUSSION

From single correlation coefficients, it is found that the normal reference value of hemoglobin of middlescent women increases with altitude, and the correlation is quite significant. As altitude rises, the air becomes thin, and the oxygen content gradually reduces. In response to the lack of oxygen, the amount of red blood cells in the human body gradually increases. It induces a rise of the normal reference value of hemoglobin of middlescent women [92].

If the altitude of a particular area in China is known, the normal reference values of hemoglobin of middlescent women in this area can be calculated according to the regression equation. For example, in the Beijing area, the altitude is 31.2 m. By means of the regression equation, the following can be calculated:

$$\begin{aligned}\hat{Y} &= 125.5 + 0.008057 \times 31.2 \pm 18.5 \\ &= 125.8 \pm 18.5\end{aligned}$$

So, the calculated normal reference value of hemoglobin of middlescent women can be obtained, and the normal reference value of hemoglobin of middlescent women is 125.8 ± 18.5 g/l.

DIVISION

The topographical outline of China is a three-step, west-east staircase. According to the normal reference value of hemoglobin of middlescent women, and taking the altitude as the main differentiat-

ing factor, China can be divided into three districts.

Qingzang District

The highest western area, 4,000 m above sea level, includes the Qingzang plateau. It includes the Tibet Autonomous Region and Qinghai Province. Its altitude is the highest, so its hemoglobin is the highest in China. Take the Lhasa area as an example: the altitude there is 3,658 m. Using the regression equation, the calculated normal reference value of hemoglobin of middlescent women can be obtained as follows: 155.0 ± 18.5 g/l.

Central District

Further to the east, behind the Kunlun Mountains and Qilian Mountains on the plateaus northern edge and the Hengduan Mountains on its eastern edge, the land slopes down to highlands and basins (2,000 to 1,000 m above sea level). This district includes Sichuan Province, Chongqing city, Guizhou Province, Yunnan Province, Shaanxi Province, Gansu Province, the Xinjiang Uygur Autonomous Region, the Ningxia Hui Autonomous Region, the Inner Mongolia Autonomous Region and Shanxi Province. Its altitude is medium, so its hemoglobin is at a medium range for China. For example, in the Yinchuan area, the altitude is 1111.5 m.

Using the regression equation, the calculated normal reference value of hemoglobin of middlescent women can be obtained as follows: 134.5 ± 18.5 g/l.

The Eastern District of low hemoglobin

Further to the east still, China descends further to hilly regions and plains mostly below 500 m. This district includes Taiwan Province, Hainan Province, Guangdong Province, Hongkong Special Administrative Region, Macao Special Administrative Region, the Guangxi Zhuang Autonomous Region, Shanghai city, Jiangsu Province, Zhejiang Province,

Anhui Province, Fujian Province, Jiangxi Province, Hunan Province, Hubei Province, Beijing city, Tianjin city, Hebei Province, Shandong Province, Henan Province, Liaoning Province, Jilin Province and Heilongjiang Province. Its altitude is the lowest, so its hemoglobin is the lowest in China. For example, in the Beijing area the altitude is 31.2 m. Using the regression equation, the calculated normal reference value of hemoglobin of middlescent women can be obtained as follows: 125.8 ± 18.5 g/L.

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