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Normal reference value of hemoglobin of young women and geographical factors in China

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A research is conducted on the relationship between the normal reference value of 20,475 examples of hemoglobin of young women and five geographical factors in 208 areas in China, the normal reference value is determined by the hemoglobincyanide method. It is found that the correlation of geographical factors and the normal reference value of hemoglobin of young women are quite significant (F=142.81). By using the method of multiple linear regression analysis, one regression equation is inferred. If geographical values are obtained in some areas, the normal reference value of hemoglobin of young women of this area can be reckoned by using the regression equation. Furthermore, depending on the geographical factors, China can be divided into six regions: Qinghai-Tibet (Qingzang) Plateau, Southwest, Northwest, Southeast, North and Northeast China.

Normal reference value of hemoglobin of young women and geographical factors in China GE Miao (Department of Geography, Shaanxi Normal University, Xi´an 710062, China) 1 Introduction Hemoglobin is an important index of haematology. 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 young women´s hemoglobin in China. Many researchers have measured the normal reference value of local young women´s hemoglobin (Yao et al., 1993; Li, Wang, Han, 1997; Ye et al., 1997; Shen et al., 1993; Ye, 1996; Zhu et al., 1998; Lu et al., 1997; Li et al., 1993; Yang et al., 2000; Wu et al., 1998; Yang et al., 1998; Cai and Xu, 1998; Chen, Lu, Chen, 2000; Zhang, Hu, Dong, 2001; Qiu et al., 2001; Chen and Zhu, 2001; Song et al., 2000; He et al., 2001; Mi et al., 2000; Lu et al., 2001; Chen et al., 2001; Cai et al., 2001; MMA, 1996; Duan et al., 2001; Hu et al., 2001; Xiang et al., 2001; Kong, 1998; 2002; Wang et al., 1999;Ji et al., 2002; Mei et al., 2001; Jiang et al., 2002; Zhang, Wang, Ye, 2001; Hu et al., 1995; AT, 1996; Li, Zhu, Yi, 1997; Ma et al., 1993; Liu et al., 1992; Wang et al., 1998; Deng et al., 1995; Li, 1996; Duan et al., 1999; Xia et al., 1995; Wang et al., 1993; Sun et al., 2001; He et al., 1999; Zhang and Wang, 1996; Jiang et al., 1988; Wang and Zhao, 1995; 1996; Leng and Hu, 1993; Zhou, 1994; Li and Fan, 1988; Feng and Yang, 2000; Cheng, 1997; Lu et al., 1995; Ren and Cao, 1995; 1996; Zhao, 1991; Xin et al., 1995; Zhao et al., 2001; Wen, 1997; Du and Zhang, 2001; Xu, 1996; Cao, Ren, Yin, 1999; Guo et al., 1998; Cao, Yin, Ren, 1999; Man et al., 1991; 1992; Zhang et al., 1989; Fu and Lu, 1999; Chen et al., 1989; Li, 1998; Kong et al., 1998; Sun et al., 1994; Huang and Li, 1999; Bo et al., 2001; Chen, Hu, Deng, 2000;Xia et al., 2002). No reports on the relationship between the normal reference value of young women´s hemoglobin and geographical factors have been found. By means of correlation and multiple linear regression analysis, research on the relationship between the normal reference value of young women´s hemoglobin and geographical factors has showed that there are certain regular patterns between the normal reference value of young women´s hemoglobin and geographical factors. 2 Materials 2.1 The normal reference value of young women´s hemoglobin The normal reference values of healthy young women´s hemoglobin from various administrative units (hospitals, research institutes and universities) have been collected in China. They include the normal reference values of 20,475 young women´s hemoglobin tested in 208 units. The ages of the volunteers range from 18 to 25. It is a mean value of young women´s hemoglobin in each area, and 50-210 random samples have been studied in every area. The determination of the normal reference value of young women´s hemoglobin is performed according to the hemoglobincyanide method (Ye et al., 1997). In this routine method: first, add 20-microlitre whole blood into 5-milliliter HiCN reagent; next, mix the two kinds of liquid completely and rest the mixture standing for 5 minutes; then, use a spectrophotometer which has been zeroed with HiCN reagent at a wavelengh of 540 nanometers an

d a photic road of 1.000 centimeter to determine absorbency; and last, use the concerned formula to calculate the hem oglobin. The normal reference values of hemoglobin are expressed in g/L. 2.2 The geographical factors The geographica l factors come from relevant geographical works and dictionaries (Yan et al., 1991; Zhao et al., 1999). The selected geographical factors include altitude (0-5,500 m), annual sunshine hour (1,000-3,600 h), annual average relative humi dity (30-85%), annual average temperature (-10-26oC) and annual precipitation (30-2500 mm). 3 Regression analysis 3.1 Correlation analysis By using the method of mathematical correlation analysis (Zhang and Yang, 1991), single corr elation coefficients between the normal reference value of young women´s hemoglobin and five geographical factors (al titude, annual sunshine hour, annual average relative humidity, annual average temperature and annual precipitation) can be calculated respectively: r1=0.870, r2=0.298, r3=-0.510, r4=-0.763, and r5=-0.489. Degrees of freedom N-2=208-2 =206, critical value of correlation coefficient is obtained from the tables in some concerned books: r0.01=0.179, r 0.05=0.137. If |r| is higher than 0.179, it means the correlation is quite significant. If |r| is lower than 0.137, i t means the correlation is not significant. If it occurs between 0.179 and 0.137, the correlation is just significan t. 3.2 Regression equation By using the method of multiple linear regression analysis, one regression equation is inf erred according to the normal reference value of young women´s hemoglobin and geographical factors: = 94.1 + 0.007939 X1 + 0.003979X2 + 0.4760X3 - 0.4120X4 - 0.003795X5 ±14.8 In the above equation, is the normal reference value of you ng women´s hemoglobin (g/L); X1 is the altitude (m); X2 is the annual sunshine hour (h); X3 is the annual average rel ative humidity (%); X4 is the annual average temperature (oC); X5 is the annual precipitation (mm); 14.8 are the valu e of the 1.96 residual standard deviations (Zhou et al., 1995). By using the F-test, F equals 142.81. From the table s in some concerned books, F0.01 (5,208-5-1)=3.11 can be obtained. The F0.01 (5,208-5-1) is lower than F. This indica tes that the correlation is quite significant in young women´s hemoglobin. 4 Discussion From single correlation coeff icients, it is found that the normal reference value of young women´s hemoglobin increases with altitude, the correla tion is quite significant and the relation is the closest. With the increase of the annual sunshine hour, the normal reference value of young women´s hemoglobin also increases, the correlation is quite significant, and the relation i s the slightest. With the increase of annual average relative humidity, the normal reference value of young women´s h emoglobin decreases, the correlation is quite significant. With the increase of annual average temperature, the norma l reference value of young women´s hemoglobin decreases, the correlation is quite significant. With the increase of a nnual precipitation, the normal reference value of young women´s hemoglobin decreases, the correlation is quite signi ficant. From this analysis, it can be concluded that altitude is the main factor affecting the normal reference valu e of young women´s hemoglobin. 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 ris e of the normal reference value of young women´s hemoglobin (Ge, 2001). If the geographical factors of a particular a rea in China are known, the normal reference values of young women´s hemoglobin in this area can be calculated accord ing to the regression equation. For example, in the Beijing area, the altitude is 31.2 m, the annual sunshine hour i s 2,780.2 h, the annual average relative humidity is 60.0%, the annual average temperature is 11.5oC, and the annual precipitation is 644.2 mm. By means of the regression equation, the following can be calculated: = 94.1+0.007939×3 1.2+0.003979×2780.2+0.4760×60.0-0.4120×11.5 -0.003795×644.2±14.8 = 126.8±14.8 So, the calculated normal referen ce value of young women´s hemoglobin can be obtained, the normal reference value of young women´s hemoglobin is 126.8 ±14.8 g/L. 5 Division The topographical outline of China is a three-step West-East staircase. It is high in the west ern area and low in the eastern area. It begins with the Qinghai-Tibet (Qingzang) Plateau, which is mostly 4,000 m ab ove sea level. Crossing the Kunlun and Qilian mountain ranges on the plateau´s northern edge and the Hengduan Mountai ns on its eastern edge, the land slopes away to highlands and basins mostly from 2,000 to 1,000 m above sea level; th en it descends further eastward to hilly regions and plains mostly below 500 m. With the gradual reduction of annual sunshine hours in a Northwest-Southeast direction, the annual average temperature gradually rises from north to sout h, and the annual average relative humidity and the annual precipitation gradually increase in a northwest-southeast direction. The population is much denser in the eastern area than in the western area. According to the similarity o f the normal reference value of young women´s hemoglobin and taking altitude as the main differentiating factor, Chin a can be divided into three parts, namely: the western part, the middle part and the eastern part. Furthermore, on th e basis of altitude, referring to distribution of population density and the other geographical factors, we can divid e one region in the western part (Qinghai-Tibet Plateau), two regions in the middle part (Southwest and Northwest), a nd three regions in the eastern part (Southeast, North and Northeast). Then, we will have the following six regions i n China (Figure 1). 5.1 Qinghai-Tibet Plateau It includes the Tibet Autonomous Region and Qinghai Province. For examp le, in the Lhasa area, the altitude is 3,658.0 m, the annual sunshine hour is 3,007.7 h, the annual average relative

humidity is 45.0%, the annual average temperature is 7.5oC, and the annual precipitation is 454.0 mm. Using the regression equation, the calculated normal reference value of young women´s hemoglobin can be obtained as follows: 151.7±14.8 g/L. 5.2 Southwest China It includes Sichuan Province, Chongqing City, Guizhou Province, and Yunnan Province. For example, in the Guiyang area, the altitude is 1,071.2 m, the annual sunshine hour is 1,371.0 h, the annual average relative humidity is 79.0%, the annual average temperature is 15.3oC, and the annual precipitation is 1,174.7 mm. Using the regression equation, the calculated normal reference value of young women´s hemoglobin can be obtained as follows: 134.9±14.8 g/L. 5.3 Northwest China It includes Shaanxi Province, Gansu Province, the Xinjiang Uygur Autonomous Region, the Ningxia Hui Autonomous Region, the Inner Mongolia Autonomous Region and Shanxi Province. For example, in the Yinchuan area, the altitude is 1,111.5 m, the annual sunshine hour is 3,039.6 h, the annual average relative humidity is 59.0%, the annual average temperature is 8.5oC, and the annual precipitation is 202.8 mm. Using the regression equation, the calculated normal reference value of young women´s hemoglobin can be obtained as follows: 138.8±14.8 g/L. 5.4 Southeast China It includes Taiwan Province, Hainan Province, Guangdong Province, Hong Kong 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 and Hubei Province. For example, in the Nanchang area, the altitude is 46.7 m, the annual sunshine hour is 1,903.9 h, the annual average relative humidity is 77.0%, the annual average temperature is 17.5oC, and the annual precipitation is 1,596.4 mm. Using the regression equation, the calculated normal reference value of young women´s hemoglobin can be obtained as follows: 125.4±14.8 g/L. 5.5 North China It includes Beijing City, Tianjin City, Hebei Province, Shandong Province and Henan Province. For example, in the Beijing area, the altitude is 31.2 m, the annual sunshine hour is 2,780.2 h, the annual average relative humidity is 60.0%, the annual average temperature is 11.5oC, and the annual precipitation is 644.2 mm. Using the regression equation, the calculated normal reference value of young women´s hemoglobin can be obtained as follows: 126.8±14.8 g/L. 5.6 Northeast China It includes Liaoning Province, Jilin Province and Heilongjiang Province. For example, in the Changchun area, the altitude is 236.8 m, the annual sunshine hour is 2,643.5 h, the annual average relative humidity is 65.0%, the annual average temperature is 4.9oC, and the annual precipitation is 593.8 mm. Using the regression equation, the calculated normal reference value of young women´s hemoglobin can be obtained as follows: 133.2±14.8 g/L.

关键词： hemoglobin; reference value; geographical elements; regression analysis

