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Analysis of Heart Rate Variability of College Students in Altitude Training Based on Big Data

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Abstract

Heart activity is regulated by sympathetic and parasympathetic autonomic nerves, which is a common method to measure and evaluate autonomic nerve activity. Collecting ECG data of college students and analyzing heart rate variability can evaluate autonomic nerve activity of college students. This paper discusses the influence of altitude training on students' heart rate variability, and the influence of altitude hypoxia and low pressure on students' autonomic nervous system, which provides a scientific basis for coaches to control the training intensity and amount and reduce the risk factors. The results show that good adaptability of altitude training can improve the activity ability of the vagus nerve.

Keywords: Big Data; College Students; Altitude Training; Heart Rate Variability

1. Introduction

Healthy body is the basis and premise of the great rejuvenation of the nation. Only with a healthy body can college students become comprehensive and high-quality talents and make corresponding contributions to the country [1-2]. In the field of physical education teaching in colleges and universities, too much attention is paid to the reform of teaching contents and teaching methods, and not enough attention is paid to the physique of students. In particular, the importance of strength to improve students' physique in an all-round way, physical exercise methods are too traditional, therefore, contemporary college students' physical exercise is not good, physical quality is poor, physical exercise effect is poor. It is a general trend of the times to enrich physical education teaching content and choose effective practical means and methods [3-4].

Many experts and scholars at home and abroad have done a lot of research in this aspect. Some scholars take healthy people as the research object, HRV as the experimental index, and observe the risk of arrhythmia in healthy people when they exercise at 8135m altitude. The results show that the HRV index measured in the plateau environment is lower than that in the plateau environment under the quiet state, and the HRV index measured in the plateau environment is lower than that in the plateau environment [5-6]. The HRV index measured at high altitude is also lower than that measured at high altitude. The test results show that the sympathetic nerve activity is significantly enhanced. Sports activities at high altitude have the risk of arrhythmia for participants. Other researchers have also studied the effect of hypoxia on the recovery of heart rate variability, and the results show that the effect of hypoxia on the function of the autonomic nervous system presents a similar trend [7-8].

All the above studies have proved that the plateau environment or the hypoxia environment of the simulated plateau environment will affect the plateau environment. The change, but the college students in the plateau training in-depth research is needed for change. At present, there is no report on the effect of higher education on college students'

autonomic nervous system, so this paper discusses the influence of altitude training on college students' autonomic nervous system by monitoring the index of heart rate variability before and after altitude training. It lays a theoretical foundation for the application of heart rate variability in plateau monitoring [9-10].

2. Literature Review

2.1. Heart Rate Variability Theory

Heart rate variability (HRV) is also known as heart rate responsiveness (HRV) or heart rate cycle variability (CPV). HRV reflects the ability of the nervous system to regulate the heart and is an important index to evaluate the function of the system. The linear analysis of the original RR interval signal reflects the overall change of heart rate variability, not the instantaneous change of heart rate. The linear heart rate variability can explain the current heart rate, reflect the change of current heart rate, and receive more heart rate variability information, but it is more complex than the linear method. Fractal is also a powerful tool to analyze nonlinear signals. Fractal signals are generally unstable and irregular, but they have certain regularity in local details. The regularity of signals is the same. In the real world, statistical self similarity is more common. Fractal has the following characteristics: 1) fractal has good structure on various scales; 2) the goods of various sizes are in good structure; 3) fractal is very irregular and difficult to describe and measure in European geometry; 4)fractal has local self similarity and global self similarity. Self similarity can be expressed by rule self similarity and statistical self similarity [11-12].

2.2. Relationship Between Heart Rate Variability and Altitude Training for College

Students Height training is a kind of compensation mechanism, which uses the environment of low pressure and high level of hypoxia to stimulate the body of students, and fully mobilizes the physical and physiological functions of students by increasing the difficulty and tension of training. At present, many anti-hypoxia training methods have been formed, and altitude training has become a common training method for endurance trainers. When people are in a plain environment, the control of the cardiovascular system by sympathetic and parasympathetic autonomic nerves is in a relatively balanced state. With the assistance of other system functions, this relative balance ensures the relative stability and strain ability of blood vessel and heart rate activity, but when people enter the low pressure and hypoxia environment at high altitude, the balance between autonomic nerves is destroyed, which changes from adaptive regulation to dysregulation, and the cardiac activity regulated by autonomic nerve is affected and the heart rate is disordered. The change of parameters can observe the abnormal heart rate, which can play a predictive role in sudden exercise death. The application in altitude training plays a timely and effective role in monitoring the regulation of autonomic nerves in plateau environments, and it is very important for college students to train at high altitude.

2.3. Research Method of Big Data in Heart Rate Variability

2.3.1. HRV Time Domain Analysis Method

Time domain analysis is the earliest analysis method of HRV. It studies the degree of HRV transient changes caused by a certain stimulus through statistical discrete trend analysis of RR interval sequence. The time domain analysis of HRV can be divided into two ways: statistical analysis and geometric analysis. Geometry analysis is to analyze the distribution of RR intervals and observe the change of HRV through geometry. There are two common methods. One is to draw histogram through the distribution of HRV interval, and further deduce the reference index of HRV analysis with the

parameters such as the height and width of histogram. The histograms include: RR interval histogram, RR interval difference histogram, etc. The other is to use other graphics, such as triangles, instead of histograms, and then extract the features of graphics to obtain the analysis index of HRV. Geometric method is not sensitive to abnormal heart rate in HRV analysis, but it usually needs a long time to collect ECG data, so it is suitable for long-term ECG analysis. Statistical analysis method is simple and fast, long-term and short-term ECG signals can be selected according to the

characteristics of indicators. In this paper, because of the analysis of short-term HRV signals, a statistical analysis method is used to extract the characteristic values from the RR interval sequence.

2.3.2. HRV Statistical Index

In the continuous development of HRV time domain analysis, some statistical indicators are proposed, among which the commonly used indicators are as follows:

1) SDNN: standard deviation of normal sinus interval (NN), which reflects the overall mean of all NN intervals.

$$SDNN = \sqrt{\frac{\sum_{I=3}^{H} (NN_3 - \overline{NN})^2}{H-1}} \quad (1)$$

In Formula 1, n is the number of NN intervals. I is the sequence number of heart beat sequence, NNJ is the ith NN interval, NV is the average value of n intervals, the same sign in the following formula has the same meaning.

2) SDANN: the standard deviation of the mean value of the NN interval of all continuous 6 minutes in 24 h ECG. The 24-hour ECG signal will be collected and divided into 300 copies at 6-minute intervals. The average value of the NN interval in each ECG signal will be calculated, and then the standard deviation of the average value of these 300 NN intervals will be calculated.

$$SDANN = \sqrt{\frac{\sum_{I=1}^{K} (\overline{NN_i} - \overline{NN})^2}{K}} \quad (2)$$

2.4. Characteristics of Plateau Training for College Students

In the environment of high altitude hypoxia and low pressure, college students not only have more red blood cells in their blood, but also have changes in their autonomic nervous system. The results showed that the sympathetic activity of college students increased after they first went to high altitude. After exercise load, the sympathetic activity increased significantly. HRV was earlier than the biochemical index in identifying fatigue, and vagus activity increased after they went to high altitude. In the absence of any stimulation, the hypothalamic autonomic nerve center regulates cardiovascular activities through sympathetic and parasympathetic nerves, stimulating sympathetic nerves to play an exciting role, while parasympathetic nerves inhibit activities, so as to achieve a dynamic balance in the control of heart, brain and peripheral blood vessels.

3. Methodology

3.1. The Proposal of Experiment

3.1.1. Selection of Experimental Group

There are 50 college students, including 25 boys and 25 girls. Their physical conditions are shown in Table 1. The altitude training time is June 2020. The altitude of College Students' residence is 1600m, the altitude of training is 2000-2500m, and the humidity is 30% ± 5%. The training time lasts for three weeks.

Table. 1. Natural situation of the subjects

Gender	Age (year)	Height (cm)	Weight (kg)	Training life (years)
Male	18.58 ±3.91	172.79 ±11.04	64.21 ±9.36	7.83 ±9.19
Female	18.66 ±3.98	166.84 ±10.44	56.08 ±6.12	6.83 ±9.19

Due to the difference in the size of height and weight indicators, the value of the index is different from that of the control group. The index has no effect, so it does not test the difference of height and weight of male and female college students, and makes an independent sample of the age and training years of male and female college students. The results showed that there was no significant difference in age and training years.

3.1.2. Selection of Experimental Group

The experiment was carried out two days before the beginning of altitude training and two days after the end of altitude training. The two indexes were collected at 6:30-7:30 in the morning. In order to ensure that the amount of exercise on the day before the two examinations was similar, the students could not drink tea, coffee or alcohol on the day before the training, and could not take drugs that affect heart activity. Considering the influence of the physiological cycle of female college students on the indicators, we investigate the physiological cycle before the test, and exclude the female college students who are in the physiological cycle during the test time. At the beginning of the test, students must sit still for 5 minutes to keep their breathing and heart rate stable. College students in the rest, supine position, through the power laboratory to register routine ECG for 5 minutes. The collected ECG signals were analyzed and processed by MATLAB heart rate analysis software, and the ECG signals of standard lead II limb were collected by electronic electrocardiograph. The non right upper arm blood pressure of college students was measured, and the blood pressure and ECG data were obtained.

3.2. Questionnaire Survey Method

Objective to investigate the subjective fatigue symptoms of college students, this paper will collect the subjective fatigue state of college students before and after altitude training, and evaluate the difference of fatigue degree of college students before and after altitude training. Mental symptoms and neurosensory symptoms are three aspects to evaluate the degree of physical fatigue of college students.

4. Result and Discussion

4.1. Characteristics of Physical Indexes of College Students in Altitude Training

Figure. 1. Physical index characteristics of speed skaters before and after plateau training

It can be seen from Figure 1 that the total power TP index has decreased, but the decrease is small. After logarithmic transformation, the data are compared before and after altitude training, but there is no significant difference. The median of TP before altitude training (P25, p75) was 5400.93 (3993.266689.7) and 3342.48 (1757.5111856.4) after

altitude training. From the overall data, the range of female college students' TP after altitude training expanded and the median increased; Hfnu decreased significantly after altitude training, and there was no significant difference after log conversion of VLF index after altitude training. From the VLF data as a whole, it shows that the overall sympathetic activity of female college students has been strengthened to a certain extent.

4.2. Characteristics of Spiritual Indexes of College Students in Plateau Training

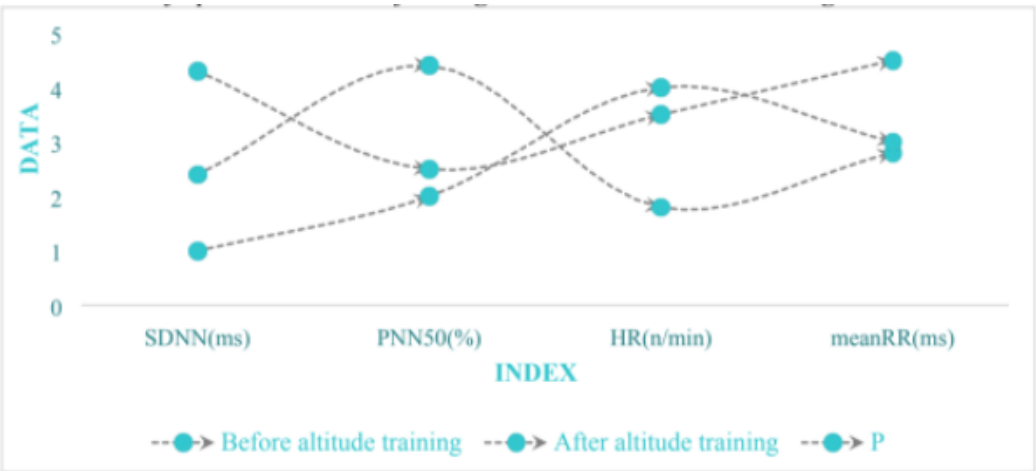

Figure. 2. Characteristics of mental indexes of college students in altitude training

Figure 2 shows the change of time domain indexes of college students before and after training at Plateau. From the values in Figure 2, SDNN has a mean value decrease after altitude training. RMSSD data belongs to a partial normal distribution. There is no significant difference in statistical comparison after logarithm conversion. The median of RMSSD before training at Plateau (P25, p75) is 84.74 (64.53107.37). The results show that the RMSSD index has decreased after training at high altitude, but the change is not statistically significant. There was no significant difference between the heart rate index and RR interval index after high altitude, which indicated that the vagus nerve activity of college students decreased after training at high altitude, but the sympathetic activity was less affected.

5. Conclusion

Heart rate variability signal (HRV) is the periodic change of sinus heart rate in a certain period of time. The high altitude hypobaric hypoxia environment has a load stimulating effect on students' heart activity, cardiovascular system and respiratory system. With the changes of heart activity and respiratory system, it constantly adapts, increases cardiac output and provides more oxygen for exercise. Its activity changes with the oxygen transport function of the cardiovascular system. After altitude training, the frequency index HF of vagus nerve activity increases, which indicates that the vagus nerve activity increases after altitude training. Therefore, good adaptability of altitude training can improve the activity ability of the vagus nerve.

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