Research on the Influence of Aerobic Exercise on Athletes' Body Shape and Function Based on Multiple Linear Regression

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Abstract: Cardiopulmonary Function Test of Athletes is the Key to Scientifically and Reasonably Formulate Training Plans. in Order to Solve the Problem of Large Errors in the Existing Cardiorespiratory Function Detection Methods, a Multiple Linear Regression Cardiorespiratory Function Detection Method Based on Particle Swarm Optimization is Proposed. through Significant Difference Correlation Evaluation, the Metabolic Circulation Function in Sports is Analyzed to Realize Comprehensive Evaluation of Athletes' Absolute Strength, Speed Strength and Strength Endurance, and the Internal Relationship between Athletes' Aerobic Metabolism Ability and Anaerobic Metabolism Ability is Obtained. the Results Show That 3 Months Aerobic Exercise Can Obviously Improve the Body Shape and Physiological Function of Young Women. Particle Swarm Optimization is Used to Optimize and Improve the Speed and Accuracy of Cardiopulmonary Function Detection. the Method Can Effectively Improve the Cardiopulmonary Function of Athletes Before and after Aerobic Training, and Has High Modeling Accuracy.

1. Introduction

Aerobic Calisthenics Refers to the Rhythmic Exercises That the Human Body Performs under the Condition of Aerobic Energy Supply, Integrating Dance, Gymnastics and Skill Movements [1]. Aerobic Exercise is a Way to Absorb Gymnastics and Dance Skills and Exercise under a Certain Music Rhythm through Aerobic Energy Supply. in the Past, Most of the Theories and Researches Related to the Effects of Health Exercises Were Aimed At the Elderly [2]. the Harmonious Beauty of Human Body Shape is Mainly Reflected in the Symmetry of the Left and Right Sides of the Body, with Certain Objective Indexes, Such as Reasonable Proportion of Height and Weight, Chest Circumference, Waist Circumference, Hip Circumference and Other Indexes Conforming to the Golden Section Law, Which is One of the Conditions for External Beauty of Body Shape [3]. in This Paper, a Dynamic Detection Model of Athletes' Metabolic Circulation Function Based on Multiple Linear Regression Analysis Method is Proposed to Realize Comprehensive Evaluation of Athletes' Absolute Strength, Speed Strength and Strength Endurance, and to Obtain the Internal Relationship between Athletes' Aerobic Metabolism Ability and Anaerobic Metabolism Ability. According to the Physiological Characteristics of Athletes, Reasonable Exercise Content is Formulated to Guide Athletes to Carry out Scientific Exercise, Aiming At Improving the Physical Structure of Athletes and Improving Their Health Level.

2. Cardiopulmonary Function Test Model

Scientific and Reasonable Indexes Are the Basis for Cardio-Pulmonary Function Test in Aerobic Training of Athletes. in Order to Effectively Evaluate the Cardiopulmonary Function of Athletes, Cardiopulmonary Function Indexes Are Divided into Three Categories: Oxygen Intake, Carbon Dioxide Emission and Heart Rate [4]. Aerobic Calisthenics Insist on Exercise, Which Can Significantly Reduce the Body Fat Content. to Promote Endurance and Physical Strength, So That Oxygen Metabolism Function is Effectively Promoted, Thus Improving Vital Capacity. in Addition, a Healthy Body Must Have Good Visceral Functions, Especially Heart and Lung Functions. Many Studies Have Shown That Aerobic Exercise Can Eliminate Excess Fat in the Body, Reduce Body

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Fat, Improve Heart and Lung Functions, and Prevent Cardiovascular Diseases [5]. According to the Three Basic Indexes, Four Specific and Representative Characteristics That Can Further Evaluate the Cardiopulmonary Function of Athletes Are Developed, Namely Respiratory Entropy, Oxygen Pulse, Anaerobic Valve and Ventilation Volume Per Minute. the Cardiopulmonary Function Detection Index Model is Shown in Figure 1. through the Construction of Athletes' Cardiopulmonary Function Evaluation Index System, It Provides a Platform and Data Basis for Multi-Linear Regression Dynamic Detection of Athletes' Metabolic Circulation Function.

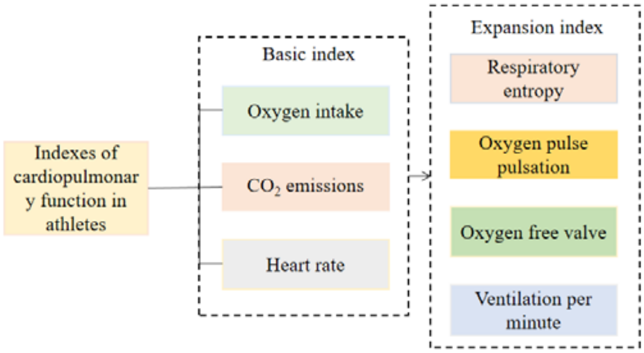

Fig.1 Aerobic Cardiopulmonary Exercise Testing Evaluation Model

The specific evaluation of athletes' heart rate is the maximum heart rate. The maximum heart rate of athletes is usually calculated by empirical formula, which can be expressed as [6]:

$$H_{R\max} = 220 - A_{ge} \tag{1}$$

Where Age means the age of the athlete.

The maximum oxygen uptake is the key feature for evaluating the cardio-pulmonary function of athletes after aerobic training. The specific calculation method is as follows:

$$V_{O2\max} = H_{R\max} \times M_{SV} \times O_{PD} \tag{2}$$

Among them, H Rmax is the maximum heart rate; M SV is the average value of the stroke volume in the blood pulse of the heart function, and the oxygen pulse difference between the arterial and venous of the O PD athlete.

Respiratory entropy represents the respiratory exchange efficiency of athletes after aerobic training. The specific calculation method can be expressed as follows:

$$R_Q = \frac{V_{o2}}{V_{co2}} \tag{3}$$

Among them, V O2 represents oxygen intake; V CO2 represents carbon dioxide emissions.

The specific characteristics of athletes' oxygen intake are usually evaluated by athletes' maximum oxygen intake. The original sample data of dynamic detection and evaluation indexes of athletes' metabolic circulation function were obtained, and the dynamic detection of athletes' metabolic circulation function was carried out based on multiple linear regression analysis method [7]. The subjects sat quietly for 10 minutes before exercise, and measured the quiet heart rate 3 times per minute and averaged it. Measurement of heart rate during exercise: the subjects measured their immediate pulse at the end of different exercises during exercise, once in each exercise phase; In addition, fat consumption and consumption rate will be different under different exercise intensities. Fat consumption is inversely proportional to exercise intensity. If the intensity of exercise is extremely high, the minimum fat consumption can reach about 15% of the total consumption [8]. Anaerobic valve is also called lactic acid valve, which is the accumulation of lactic acid in athletes after aerobic exercise to anaerobic exercise. Anaerobic valve represents the increase degree of athletes' exercise load. Sigma test was carried out on the collected data before and after the two training periods. VO2max/kg, which can reflect the function of aerobic metabolism cycle, was taken as the independent variable, and other indexes were taken as the dependent variable, and a multiple linear regression equation plane was built into the standard.

3. Particle Swarm Optimization Multiple Linear Regression Detection Algorithm

3.1 Multiple Linear Regression Algorithm

Based on the cardio-pulmonary function test model of athletes' aerobic training in the previous section, sample data representing athletes' cardio-pulmonary function can be effectively obtained. In this section, a multi-linear regression model is used to construct a detection algorithm that can detect the cardio-pulmonary function of athletes after aerobic training, so as to realize the dynamic detection of cardio-pulmonary function of athletes after aerobic training. These are the parameters to be estimated for the model. To realize multiple autoregressive dynamic tests on athletes' metabolic circulation mechanism.

Firstly, the following form of multiple regression discriminant statistics is defined [9]:

$$C_{(m)} = \frac{1}{(N-m)^{1/2}} \bullet \frac{\sum_{i=1}^{N-m} (x_i - x_{i+m})^3}{\left[\sum_{i=1}^{N-m} (x_i - x_{i+m})^2\right]^{3/2}} \tag{4}$$

In the formula, x i represents the characteristic sequence of the central lung function test of the athlete during the aerobic training process; N represents the total number of times the athlete's cardiopulmonary function is counted; m represents the interval between the two feature collections.

Aerobic exercise includes three parts: whole body aerobic exercise, local muscle strength exercise, strength exercise and stretching exercise. At the same time, high-intensity exercise is not suitable for fat reduction. Therefore, it is difficult to achieve the ideal exercise effect by some methods aiming at local positions [10]. The degree of fat reduction is not obvious. After the aerobic training of the athletes is finished, the indexes of cardiopulmonary function of the athletes are collected again and recorded. When athletes undergo aerobic training, the maximum oxygen uptake, which can best reflect the athletes' cardiopulmonary function, is defined as the independent variable, and other cardiopulmonary function detection indexes are taken as dependent variables. The multiple linear regression equation is obtained as follows:

$$x_n = \varphi_0 + \sum_{i=1}^{p} \varphi_i x_{n-i} + \sum_{j=1}^{q} \theta_j \eta_{n-j} \tag{5}$$

Among them, φ i is the coefficient of the multiple linear regression model, and θ j is the significance factor of the multiple linear regression analysis. φ i and θ j are the parameters to be estimated in the multiple linear regression model. In order to effectively realize the dynamic detection of cardiopulmonary function after aerobic training of athletes, it is necessary to define the difference significance index of the multiple linear regression model:

$$S = \frac{\left|\left\langle Q_s - Q_0 \right\rangle\right|}{\sigma_S} \tag{6}$$

In the formula, σ s represents the standard deviation of the statistical value of the cardiopulmonary function index of the athlete; <Q s> represents the average value of the statistical value of the cardiopulmonary function index of the athlete. The least squares method is used to estimate the parameters in multiple linear regression. Assuming that φ ^ i and θ ^ j represent the least square estimates of the parameters φi and θj, respectively, the observations of cardiopulmonary function testing for aerobic training of athletes can be expressed as

$$\hat{x}_n = \hat{\varphi}_0 + \sum_{i=1}^{p} \hat{\varphi}_i x_{n-i} + \sum_{i=1}^{p} \hat{\theta}_j \eta_{n-j} \tag{7}$$

After the multiple linear regression equation is established based on the least squares model, the least squares estimation value of the model can be obtained when the residual sum of squares between the dependent variable and the estimation value of the multiple linear regression model is the minimum value, thus realizing the detection of cardio-pulmonary function of athletes in aerobic training.

3.2 Particle Swarm Optimization Method

Particle swarm optimization is a simple and easy optimization method with fast convergence speed. The method assumes that the solution space is modeled as particles, and the solution process is transformed into finding the optimal particles in the particle set. Dynamic tests are carried out on various functional monitoring indexes before and after the periodic training period, and multivariate correlation analysis is carried out. As the probability distribution of index data is a common normal distribution. Aerobic exercise, on the other hand, can be carried out through coordinated exercises of all parts of the body and maintained for a long time and with moderate intensity. It can promote women's body girth to reach an ideal state. In addition, endocrine changes and body temperature increase caused by exercise can make the rest metabolism after exercise higher than that before exercise and last for at least 1 ~ 2 h or even longer.

The principle of particle swarm optimization algorithm after adding dynamic acceleration constant and inertia weight is as follows. First assume that the solution space is a D-dimensional search domain composed of k particles. Particle orientation, velocity, and position are:

$$\begin{aligned} s_i &= (s_{i1}, s_i \cdots, s_{iD}), i = 1,2,\cdots,m \\ u_i &= (u_{i1}, u_i \cdots, u_{iD}), i = 1,2,\cdots,m \\ l_i &= (l_{i1}, l_i \cdots, l_{iD}), i = 1,2,\cdots,m \end{aligned} \tag{8}$$

In the solving process, each particle corresponds to an adaptive value and velocity vector, which determine the flight (evolution) direction and distance of the particle. Before and after each stage training cycle, athletes' system function indexes are tested, and data samples are collected and screened in one stage training cycle by fasting blood sampling test, vein test and other methods. In order to further improve the optimization speed of the particle swarm, inertia weight can be added to the traditional particle swarm optimization algorithm to improve the optimization accuracy of the particle swarm and reduce the probability of the particle swarm falling into local optimization.

4. Experimental Results and Analysis

The experimental results of endurance time and cardiopulmonary peak power ratio index after aerobic training show that the cardiopulmonary function detection algorithm proposed in this paper has higher detection accuracy and better performance than the detection method based on relational model. Through the analysis of the experimental results and data, we can draw the following conclusions: the skill-oriented classes show significant differences compared with long-distance events; There is a significant difference between the maximum oxygen uptake of the same-field confrontation events of the skill-oriented type and the long-distance events of the skill-oriented type. In order to further illustrate the detection performance of the two models on athletes' cardiopulmonary function, statistics are made on the detection results of endurance time and cardiopulmonary peak power ratio, and the results are shown in Table 1. From Table 1, it can be seen that the three-month aerobic exercise exercise also has obvious influence on the physiological function of the body, which is manifested as slow heart rate and increased vital capacity in a quiet state. After exercise, there are significant differences and highly significant differences compared with before exercise. Multiple linear regression analysis is used for the table of circulatory function basis of 9 athletes, and the expected convergence curve of metabolic circulatory function detection error is obtained through multi-step iteration as shown in Figure 2. The method in this paper is used to detect metabolic circulatory function index, which has convergence and stability.

Table 1 Statistical Results of Cardiopulmonary Function Test

Indicator type	Tolerance time/s			Peak cardiopulmonary power ratio/w		
	Error minimum	Maximum error	Average error	Error minimum	Maximum error	Average error
Relational model method	7.5	104.3	40.7	2.1	25.3	10.3
The detection method in this paper	0.6	55.4	14.2	0.4	4.9	2.5

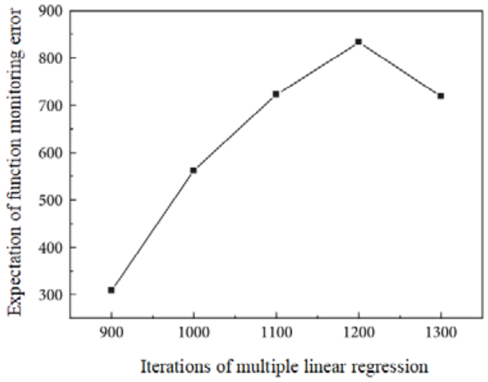

Fig.2 Expected Convergence Curve of Metabolic Cycle Function Detection Error

Through aerobic exercise, the myocardial hemoglobin content of exercisers can be increased. Promoting myocardial relaxation and tension and increasing blood supply per unit fluctuation of the heart. Therefore, the utilization rate of oxygen for exercisers is increased, and vital capacity is promoted. The performance is that the exerciser breathes more smoothly and his pulse is more vigorous than before. Compared with the respiratory frequency before exercise, the respiratory frequency decreased significantly. This may be related to the content of the class, because every class has hip exercises, especially hip lifting exercises, which may reduce the accumulation of hip fat and promote the growth of hip muscles. Therefore, insisting on taking part in aerobic exercise can reduce excess fat in the body, promote muscular development and strength, and is conducive to young women's fitness, weight loss, and achieve the goal of self-shaping and keeping fit. Using this model, we can effectively analyze the stress characteristics of exercise skeletal muscle and realize effective treatment guidance for ligament injury. The difference between the test results of athletes' cardiopulmonary function tolerance time based on particle swarm optimization multiple linear regression and the athletes' real tolerance time is small, while the error of the traditional relationship model-based test method is large, which shows that the test performance of this method for athletes' cardiopulmonary function is more superior.

According to the theory of exercise physiology, aerobic exercises with low intensity and long duration completed by human body under the condition of aerobic energy supply can improve the oxygen exchange function of respiratory system, increase lung capacity and ventilation, and improve lung function. In addition, according to research, the ratio between pulse pressure difference and systolic pressure can be increased through aerobic exercise. It indicates that the blood circulation of cardiovascular system has been improved, and the regulating function of nervous system has also been improved. Aerobic exercise can shape the body. Aerobic exercise can make people fit. Secondly, aerobic exercise can also eliminate excess fat in the body and body surface. The consumption of fat in the body is caused by many factors. Therefore, long-term aerobic exercise can enhance the body's ability to use fat for energy supply, thus increasing lean body weight and decreasing body fat percentage, which has a good effect on preventing cardiovascular diseases. After aerobic exercise, the number of pulse beats of exercisers will be reduced under a certain load intensity. This is related to the effect of aerobic exercise on improving cardiovascular function. In addition, lactic acid will not deposit during aerobic exercise, which can promote the smooth breathing of exercisers and balance the oxygen demand and oxygen intake of exercisers. Aerobic exercises of medium and low intensity and long duration completed by human body under the condition of aerobic energy supply can improve the function of respiratory system. Statistical results show that the minimum error, maximum error and average error of tolerance time and cardiopulmonary peak power ratio all indicate that the performance of the detection method in this paper is better than that of the relational model detection method.

5. Conclusion

This paper studies the testing of cardio-pulmonary model for athletes' aerobic training, and proposes a testing model of cardio-pulmonary function for athletes' aerobic training based on particle swarm optimization multiple linear regression. From the perspective of data information processing and information perception, we can quantitatively analyze the movement types and behavior patterns of human body movement behaviors, extract relevant information and express them, thus realizing accurate quantitative analysis and simulation of movement and power generation patterns of different parts of the body in the process of human body movement, and further improving the effectiveness and pertinence of athlete training and sports injury treatment. Three months of aerobic exercise can obviously improve the body shape and heart and lung function of young women. It is shown that the aerobic exercise program with a heart rate controlled within the range of 60%- 80% of the maximum heart rate three times a week and 40- 60 minutes each time has a good effect on the body circumference and heart and lung function of young women. Comparative experimental results show that the detection performance of the model on the heart and lung function of athletes' aerobic training is better than that of the traditional relational model algorithm, which provides a new way for the detection of athletes' heart and lung model. Therefore, aerobic exercise can not only improve the athletes' maximum oxygen intake, but also improve the athletes' ability to transport, store and utilize oxygen, thus effectively improving their functional aerobic endurance.

References

[1] Wu Yangchao, Wan Mingdeng, He Dinglin. (2017). Study on Physical Shape Characteristics of Male Judo Athletes in Hebei Province [J]. Sports, no. 21, pp. 39-40.

[2] Li Shuangling, Yang Guang, Song Yuhong, et al. (2019). Comparative Analysis of Body Shape and Technical Indexes of Chinese and Foreign Elite Male Ice Hockey Players [J]. Journal of Harbin Institute of Physical Education, no. 4, pp. 29-34.

[3] Qiu Shiyou. (2017). Analysis of the body shape and technical level of the world's outstanding male tennis players [J]. Sports Goods and Technology, vol. 20, no. 20, pp. 170-171.

[4] Ding Huayang, Wang Junmin. (2017,). Effects of aerobic and compound exercise on body shape and biochemical indexes of simple obese adolescents [J]. Chinese School Health, no. 12, pp. 1859-1862.

[5] Wang Yanling. (2017). Effects of 4 weeks of moderate and small intensity aerobic exercise on body fat and vital capacity of simple obese adolescents [J]. Articles for Sport and Science, no. 16, pp. 185-186.

[6] Khademi F, Akbari M, Jamal S M, et al. (2017). Multiple linear regression, artificial neural network, and fuzzy logic prediction of 28 days compressive strength of concrete[J]. Frontiers of Structural and Civil Engineering, vol. 11, no. 1, pp. 90-99.

[7] Ma J, Yu J, Hao G, et al. (2017). Assessment of triglyceride and cholesterol in overweight people based on multiple linear regression and artificial intelligence model[J]. Lipids in Health and

Disease, vol. 16, no. 1, pp. 42.

[8] Jiao B, Zhang D, Liang A, et al. (2017). Association between resting-state brain network topological organization and creative ability: Evidence from a multiple linear regression model[J]. Biological Psychology, pp. 129:165.

[9] Bin S. (2018). Load Calibration Test and Multiple Linear Regression Analysis for Hydraulic Pipeline Fittings[J]. Journal of Mechanical Engineering, vol. 54, no. 6, pp. 128.

[10] Han X, Liu Y, Yang H. (2019). A Stereo Matching Algorithm Guided by Multiple Linear Regression[J]. Jisuanji Fuzhu Sheji Yu Tuxingxue Xuebao/Journal of Computer-Aided Design and Computer Graphics, vol. 31, no. 1, pp. 84.