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Research on Computer Artificial Intelligence Algorithm to Optimize Physical Training Intensity and Recovery Cycle Model



Abstract: - This paper established an association model between high-load training and cardiac damage to minimize sports injuries. It is a key condition to promote the development of modern sports. This project intends to use 8 biochemical parameters related to high-load training to build a mathematical model of high-load training-myocardial damage. A mathematical model for high load training and cardiac damage was established. Firstly, based on sparse feature representation method, the biochemical mechanism model of high-intensity training was constructed. The energy supply law of intramuscular energy supply and the dynamic law of glycolysis energy supply during exercise were extracted. Eight biochemical parameters were obtained after high intensity training. To construct an accurate association between high-intensity training-heart damage by measuring the correlation between eight indicators of performance. The validity of the model is verified by simulation.

Keywords: Intensity Training; Track and Field Athletes; Myocardial Injury; Algorithm Design.

I. INTRODUCTION

Track and field can make every muscle of the body perform mechanical movement, improve the body's metabolism, speed up the body's garbage, and also improve the activity of internal organs. In track and field competition, by improving the oxygen transport capacity of the body, improving the anaerobic breathing capacity of the body, improving the cardiopulmonary function of the heart, thus improving the blood supply capacity of the body; Through jumping, throwing and other activities, the coordination, agility and muscle strength of the upper and lower limbs can be rapidly developed, which helps to eliminate various physiological and pathological discomfort and incoordination phenomena inherent in human beings [1]. Comprehensive sports activities help to build an all-round development of talents with good physical quality and good psychological quality. Good physique and good psychological quality are very important to the success of college students [2]. Therefore, if they can better learn and master the skills and educational skills of track and field, then they can not only get a strong body, but also make their spirit stronger, and in the future work, they can also provide more help for the masses, so as to contribute to the promotion of the physical and mental health of the masses.

In the 21st century, in order to better play the athletes' sports level and reduce the injury of heart tissue, it has become an important direction of the development of sports. In order to achieve the goal of the development of contemporary sports, people must combine scientific sports training with body function evaluation organically [3]. In this context, the accurate analysis of the internal relationship between high-load training and heart damage is an urgent and important problem in the current research of track and field sports in China. Therefore, it is a feasible method to establish a mathematical model between high load training and heart damage. This has attracted the attention of many experts and scholars [4]. The problem of heart damage caused by high load training has gradually attracted the attention of the industry, and many good solutions have emerged. At present, physical load, physiological load and subjective feeling intensity are the three ways to detect sports intensity. The intensity of the physical load refers to the amount of activity represented by the use of physical parameters such as speed, distance, time, frequency, etc. Physiological load intensity refers to the activity intensity endured by the body, such as oxygen consumption, heart rate, pulse, blood pressure, lactic acid concentration, blood sugar, etc. As a measure and evaluation index, physical load is widely used in sports teaching and competition [5]. The strength of subjective feeling is to evaluate the intensity of action through the subjective feeling of the body. Some researchers have placed an accelerometer in the atria of patients fitted with pacemakers to study the heart's output and oxygen intake. Local blood flow to the brain has been shown to be feasible under static or dynamic conditions. Some scholars have made a comparative study on the changes of blood flow velocity in neck vessels during preparation and relaxation training.

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Some scholars have used adjoint state tracking technology to establish a model of myocardial damage in track and field sports under high load conditions. Under the condition of high load exercise, it has certain influence on the heart function of athletes. Build a limit state tracker for each metric [6]. This algorithm is relatively simple, but it also has a large model error. At present, the research at home and abroad mainly focuses on the high-load training based on SVM, and the establishment of related models. In this paper, a new algorithm for high-intensity training surface optimization based on SVM theory is proposed and relaxation variables and penalty factors are introduced. The optimal problem is transformed into a dual problem. Finally, the optimal regression equation is given. This algorithm is computationally small [7]. The existing computational method can not obtain the change of muscle enzyme content in muscle tissue when constructing the relevant model. At present, there are large errors in the existing methods of high-load training and muscle injury prediction. At present, the research at home and abroad mainly focuses on the high-load movement based on nerve cells and models it. First, consider the interaction between strength training and muscle tissue as a corresponding function. A prediction model of muscle damage in track and field under the condition of high load exercise was constructed by using guided learning algorithm. This model has high precision, but it has a large amount of computation [8]. This study presents an innovative technique for elucidating the nexus between vigorous track and field athlete workouts and cardiac muscle damage through the application of enhanced conditional probability constraint modeling.

II. DESIGN OF EXERCISE LOAD FORECASTING SYSTEM

A. Hardware implementation of the system

The system is obtained by the acceleration of three dimensions and the magnetic field of space, and then the motion information of the motion is obtained by the display screen [9]. The hardware structure of the exercise load forecasting system is shown in Figure 1 (the picture is quoted in Appl.Sci.2023, 13(13), 7839).

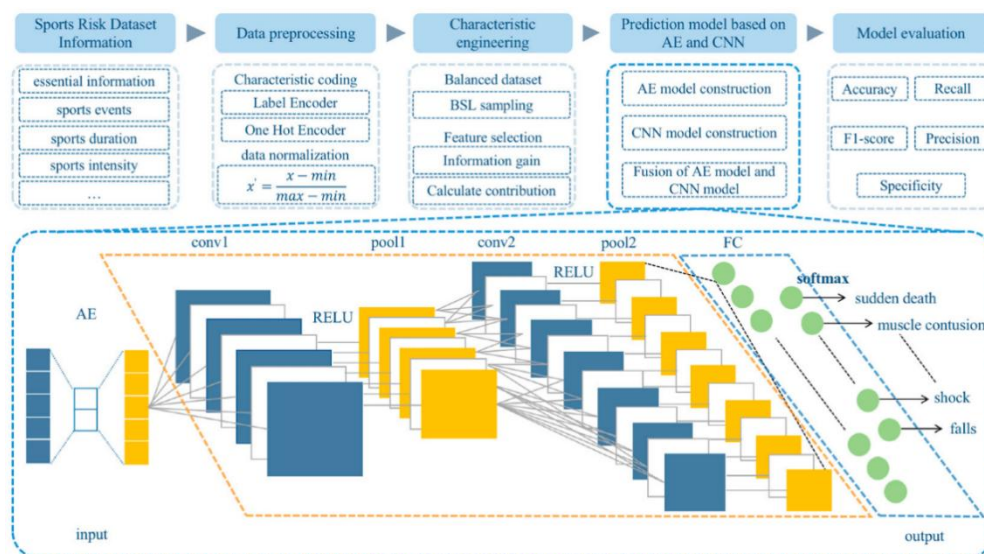


Fig.1: Hardware architecture of physical training intensity prediction system

As shown in Figure 1, the three hardware components respectively have the function of obtaining and transmitting data. Among them, the sensor network mainly completes the accurate positioning and identification of the motion behavior, especially the continuous and continuous judgment of the moving trajectory [10]. The data receiving part is mainly to sort out and filter the information such as inertia and user's usage habits obtained from the training equipment, and send these information to other terminals in a unified manner. Without additional reference points, it is impossible to locate a moving human target in real time. This requires the further development of a wide range of positioning while ensuring positioning within a certain range, so that it can better adapt to the hardware requirements of the entire system. Therefore, the purpose of the system is to accurately position the human body in motion and integrate all the position information.

A wireless network integrating infrared detectors, triaxial accelerometers, cardiac monitors, pulse sensors, and temperature probes was employed to provide real-time surveillance of five critical physiological indicators for sports coaching professionals. These indicators included heart rate, respiratory frequency, body temperature, pulse rate, and arterial oxygen saturation, leveraging the perceptive capabilities inherent in IoT technology[11].

this project connects the constructed wireless sensor network with the Bluetooth host built into the microcontroller, and transmits the physiological parameter information of the training object collected by each sensor in the sensor network to the MCU to form a one-to-many communication network. MSP430F5438 series microcontroller is used to adjust the whole system, receive and process the student physiological function information from the Bluetooth host. Because the wireless communication distance between the Bluetooth device and the device is very short, if the device is used, it must be set within the working area of the Bluetooth device [12]. But the plan requires the monitoring center to be mobile and monitor the intensity of athletes' workouts in real time. Therefore, GPRS technology is used to remotely control the microcontroller, so that it can remotely control the monitoring center, so as to achieve the emergency situation of overload. In addition, the project also builds a database of body function data based on the iot perception network, combines with training norms, produces corresponding training effects, and sends the results to the monitoring center to realize real-time monitoring of the physical status of students.

B. System software design

From the point of view of the skeletal structure of the human body, each part has its own connection, but there is a close connection between each other. Therefore, in motion capture, not only the motion parts with large range of motion and the motion parts with weak motion should be taken into account [13]. In addition, one of the characteristics of humans is that there are differences in the movement limits of each joint. From the point of view of the operation demand of the exercise training quantity forecast, in addition to obtaining correct and complete motion information, it is also necessary to obtain the data of human bone and joint rotation. By adjusting the location of each node and related parameters, the real-time prediction of training intensity is realized. With Hips node as the root node of the trainee skeleton, the displacement segment of the whole skeleton is set based on the position information of Hips node. In order to complete the assignment of tasks, it is necessary to ensure that the software of the system has a low communication cost. Because in general, the software of the system is used with the network server, so for this kind of server and carried out another communication module design. The software flow of the system is shown in Figure 2 (image cited in Machine learning methods in sport injury prediction and prevention: a systematic review).

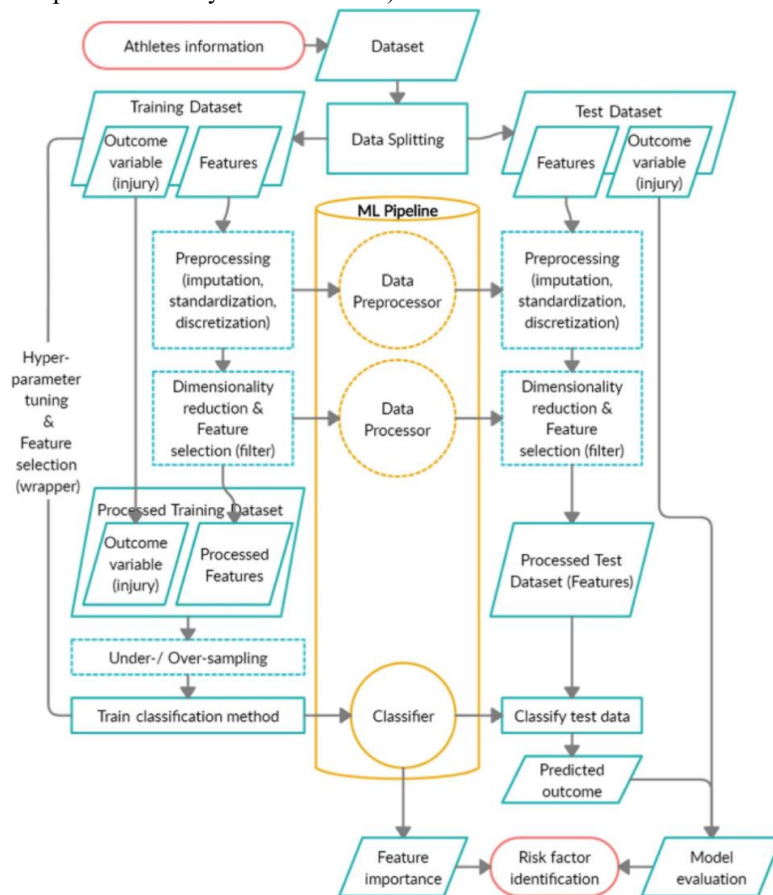


Fig.2: System software flow of sports training intensity prediction system

The core function of the device is to monitor the athlete's heart rate in real time, connect it to the microcontroller, and transmit it to the microcontroller. Therefore, this study selected Armor-XGO-HRM Bluetooth 4.0 wireless heartbeat device to obtain heartbeat data of exercise trainers [14]. Aiming at the problem that the respiratory signal baseline changes greatly when the human body moves, this project intends to use the piezoelectric three-way accelerometer to realize the active breathing of the human body and at the same time filter the baseline to obtain a stable respiratory signal. During exercise, two tests need to be performed, one is oxygenated hemoglobin and the other is reduced hemoglobin. Therefore, this project takes exercise trainers as the research object. According to their blood oxygen characteristics, infrared spectra (660 nm) and 940 nm (940 nm) of two different wavelengths are used to irradiate the finger tips of exercise trainers, so as to obtain the change rules of oxidized hemoglobin and reduced hemoglobin of exercise trainers. This project intends to take the pulse characteristics of exercise trainers as the research object, and use infrared light and 870 nm wavelength infrared light as the detection means to detect them, obtain the concentration of hemoglobin in their blood, and obtain the pulse wave related to the trainer's pulse through signal amplification and regulation. In a large number of human body temperature detection devices, a thermostatic infrared temperature measuring device using infrared light thermal effect is selected to obtain the change of body temperature during the movement of athletes [15]. A suitable sensor is selected to connect with the wireless network to form a wireless network to realize real-time monitoring of athletes' breathing.

Optimization is made using RecyclerView to restore the queue. Store each removed item in the loop queue, and remove the items that are about to enter the view from the loop queue. RecyclerView is a formal Android control whose primary goal is to display a large amount of data in a small window. This article creates the connection between items and RecyclerView from the Adapter in the Adapter class in RecyclerView. In the HomeAdapter class, people create a new class, MyViewHolder, which is done by the ViewHolder class in RecyclerView. An item is wrapped in an instance of the MyViewHolder class. Next, the paper covers several functions such as onCreateViewHolder, onBindViewHolder, getItemCount, and so on. During this process, onCreateViewHolder uses onCreateViewHolder to call this method when creating new data items without queuing from the loop. onBindViewHolder is used to bundle MyViewHolder. When the project is entered into a window, this method will take a MyViewHolder entered into this window as a parameter, and in this process, the project can be processed. Here, a spectral image is set for this project. And there is a long click monitoring event OnLongClickListener for this item, if the item is clicked multiple times, then the item will be deleted. Use the getItemCount function to get the number of data items. In addition, people have introduced both add data and move data in the HomeAdapter to add and remove data. Using RecyclerView's circular queue effectively reduces the performance burden caused by constantly breaking projects and creating new ones. At the same time, this method also stores the layout information of each item in this item, when an item is viewed, the layout information can be read from within it, thus reducing the performance burden caused by the need to load the layout again from the layout file for each item [16]. The software cannot determine whether it is a month view or a day view, or whether the viewer has received a scroll indication. The paper still uses Android's MotionEvent publishing mechanism to create a new NoScrollViewPager, which inherits from ViewPager. It overrides the onInterceptTouchEvent and onTouchEvent in NoScrollViewPager, which are both fake and do nothing with the motion event. Therefore, the left and right sliding of the viewer is prohibited, thus avoiding the problem of slider collision.

III. ESTABLISH A MATHEMATICAL MODEL OF THE EFFECT OF HIGH-LOAD TRAINING ON CARDIAC DAMAGE OF TRACK AND FIELD ATHLETES

A. Determination of cardiac biochemical parameters in athletics under high-load exercise conditions

Firstly, a biochemical mechanism model under high-load training conditions was constructed, and energy supply characteristics of energy supply after high-load training were extracted based on sparse feature representation method. 8 biochemical parameters closely related to myocardial function after high-load training were obtained [17]. Assuming that the athlete's continuous exercise time is represented, then the sample of the intensity training load of physical exercise created at this moment is, which represents the load condition of the athlete's body in the process of high-intensity training, then the biochemical physiological mechanism model of track and field athletes in the process of intensity training is constructed through the following formula. Figure 3 shows The relationship model between intensity Training and Myocardial injury in track and field athletes (the picture is quoted in The Beneficial Role of Exercise Training for Myocardial Infarction Treatment in Elderly).

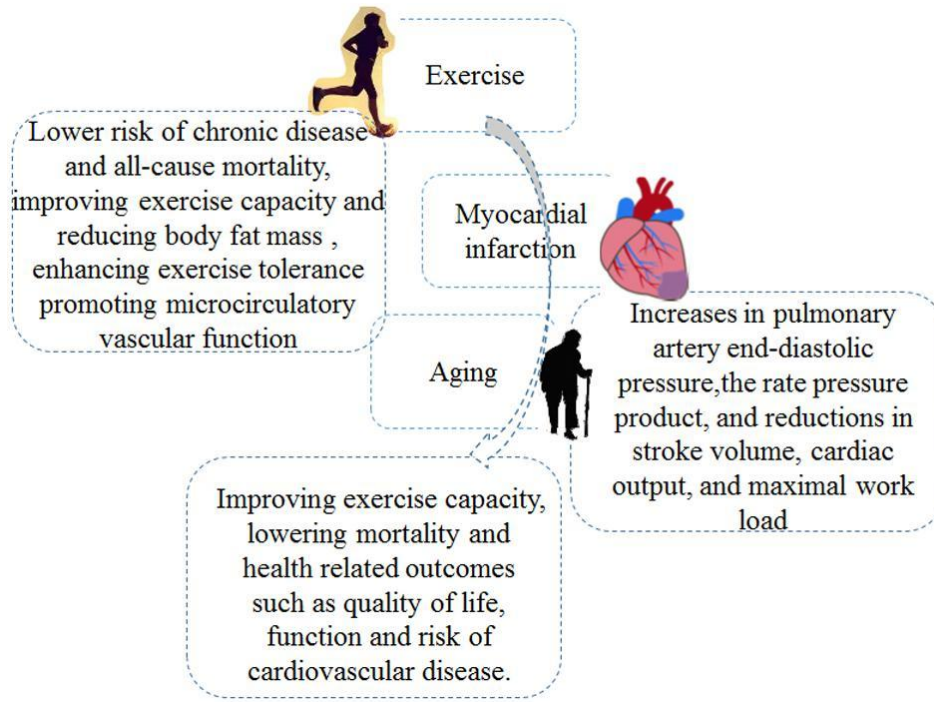


Fig.3: Relationship model between intensity training and myocardial injury in track and field athletes

$$F(u^r | u_r, AH) = \sum_{m=1}^A \beta_m S(u^r, \gamma_m, \varepsilon_m^2 E) \quad (1)$$

β_m represents the amount of physical activity a track and field athlete need to undertake during high-intensity exercise. S represents the sparse representation provided by the energy provided by anaerobic exercise during training. Where, γ_m represents the physical characteristics obtained by sparse representation and provided by both aerobic and anaerobic methods. u^r means that when the muscles contract, the body's supply of energy is direct. ε_m^2 represents the length of physical load during high-intensity exercise. E represents the physical burden borne during exercise. m stands for training impact factor [18]. According to the human biochemical physiological mechanism model constructed above, the change rule of glycolytic energy supply in the process of muscle contraction energy supply of athletes during exercise is extracted, and its expression is as follows:

$$F(u^r | AZ) = \frac{Z_{\tau d}}{F(u^r | u_r, AH)} \quad (2)$$

$Z_{\tau d}$ represents the critical value of the maximum exercise load amplitude required for the maximum lactic acid balance state during high-intensity exercise. Use the following formula to find $Z_{\tau d}$

$$Z_{\tau d} = \frac{F(u^r | FZ)F(FH)}{F(u^r | AZ)} \quad (3)$$

$F(u^r | FZ)$ indicates the maximum oxygen consumption during high-load exercise. $F(FH)$ represents the limit value of energy consumed during high load exercise. According to the following formula, eight biochemical parameters related to heart function after high-load training are obtained and expressed in the following formula

$$(u_1, \dots, u_R)^T = \frac{\partial \in R^{R \times D}}{Z_{\tau d} (\Lambda \times Z)} \quad (4)$$

Type Λ represents the sparse coding factor of the obtained training sample. Z indicates the maximum speed of movement during heavy training. ∂ represents an abnormally high value of muscle kinase at the end of training.

B. Introduction of conditional probability relation

It is assumed that PM is the "ruler" to evaluate the athlete's physique, and the performance of 8 indicators can be jointly detected according to the $(u_1, \dots, u_R)^T$ obtained from the above formula, which can be expressed by the following formula.

$$FR = \frac{[E'', RL, DM]}{(u_1, \dots, u_R)^T} \times RE \quad (5)$$

E'' represents the instability factor detected by each index. RL indicates the degree of correlation between the indices. RI represents the amount of creatine potassium phosphate that can be maintained during high-load exercise. DM represents the amount of information corresponding to each index when the training intensity changes [19]. At a certain point in time, it can reflect the heart performance of track and field athletes in the process of high-load training, and the mutual information relationship between various indicators in DM can be solved by the following formula.

$$DM(\tau) = \frac{f(di, p) \times FE}{FR} \quad (6)$$

di represents the increase in lactic acid value during high-load exercise, and F represents the change in running speed. Suppose F_{ij} is a measure of the relationship between the indicators, and FE_i represents the physical condition from the anaerobic threshold to full strength during a high-intensity exercise. Then, the relationship between FE_i and FE_j can be determined by the following formula.

$$FE_i : FE_j = \frac{f(\sum_{j=1}^S d_j w_{ji})}{f(d_i, d_j)} \times \frac{DM(\tau)}{F_{ij}} \quad (7)$$

d_j represents the amount of rest corresponding to different intensity training periods, w_{ji} represents the dominant factor of its intensity training effect, f represents the cardiac physiological compensation during high-load training, d_i represents a self-protective stress that occurs during training, and S represents the recovery state required when a serious injury is sustained. According to the above description, the following formula can be used to accurately construct the relationship between high load training and heart damage.

$$\frac{d_i \chi}{d_j} = \frac{f \times FR}{FE_i : FE_j \times DM(\tau)} \quad (8)$$

IV. SYSTEM SIMULATION

A. Set up the experimental environment

A text editor in an integrated development environment is used as the basic processing tool, and a stacked type table is used as the source code. You can use the Windows installation tool to make your new deployment. When MSDNLibrary documents are an option, you can use setup.exe to create a encapsulated file. When you configure a project using a Web server, you can use Click Once to determine if your application is in the middle.

B. System Response Time Result

This project intends to use the SVM-based exercise intensity prediction system and the deep learning-based exercise intensity prediction system, and compare with the existing exercise intensity prediction system. The experimental study of three sports items was carried out, and the reaction speed of three sports items was investigated under different simultaneous users [20]. It can be seen from Table 1 that the average response time of the exercise training intensity prediction system proposed in this paper is 2.730ms and that of the support vector machine-based exercise training intensity prediction system is 4.764ms when 100 participants are used at the same time. The average response time of the training intensity prediction system based on deep learning is 4.769 ms. After the comparison of the three auxiliary modes, it is found that the reaction speed of the three auxiliary modes proposed in this paper is 2.034 ms and 2.039 ms respectively, which shows that the auxiliary mode designed by this method is the fastest. This is a practical aid.

Table 1: System response time when the number of concurrent users is 100

number of concurrent users/users	Response time /ms of physical training intensity prediction system based on support vector machine	Response time /ms of a sports training intensity prediction system based on deep learning	The response time /ms of the physical training intensity prediction system is presented in this paper
10	2.329	2.729	1.699
20	3.655	3.039	1.785
30	3.757	3.218	1.859
40	3.937	3.561	2.006
50	4.043	3.356	2.229
60	3.865	3.569	2.296
70	4.383	3.761	2.420
80	4.605	3.827	2.490
90	4.658	4.728	2.594
100	4.764	4.769	2.730

Table 2 reveals that the mean reaction time for the exercise intensity forecasting system introduced in this study stands at 12.380 milliseconds, outperforming the support vector machine-based exercise training intensity predictor by 2.541 milliseconds, which records a response time of 14.921 milliseconds. Additionally, the deep learning-based training intensity prediction system exhibits a response time of 15.451 milliseconds. Upon evaluating the responsiveness of these three auxiliary systems, it becomes evident that the system proposed herein displays the quickest response time of 2.541 and 3.071 milliseconds when compared to the other two systems. Consequently, this indicates that the system developed in this paper boasts the most rapid response time among all systems, especially when subjected to simultaneous use by 200 individuals, surpassing its performance when utilized by 100 users.

Table 2: System response time when the number of concurrent users is 200

number of concurrent users/users	Response time /ms of physical training intensity prediction system based on support vector machine	Response time /ms of a sports training intensity prediction system based on deep learning	The response time /ms of the physical training intensity prediction system is presented in this paper
110	10.553	12.672	8.591
120	11.594	12.728	8.717
130	11.731	13.792	9.198
140	12.842	13.810	9.637
150	12.956	13.872	9.974
160	13.641	13.893	10.004
170	13.779	13.966	10.651
180	13.786	15.078	10.399
190	14.902	15.292	11.359
200	14.921	15.451	12.380

Table 3 illustrates that with 300 concurrent users, the average latency for the exercise intensity forecasting system presented in this paper is 18.334 milliseconds. In contrast, the average latencies for the support vector machine-driven exercise training intensity prediction system are 27.703 ms and 26.791 ms. A comparative analysis of these three response times uncovers that the proposed auxiliary system demonstrates faster response times by margins of 9.369 milliseconds and 8.456 milliseconds when compared to the other two systems under the scenario of 300 individuals using the system simultaneously, respectively. It can be seen that when 100 users are used at the same time, the reaction speed of the auxiliary system is obviously better than that of the control, so that the overall performance of the whole system has been greatly improved.

Table 3: System response time when the number of concurrent users is 300

number of concurrent users/users	Response time /ms of physical training intensity prediction system based on support vector machine	Response time /ms of a sports training intensity prediction system based on deep learning	The response time /ms of the physical training intensity prediction system is presented in this paper
210	18.866	22.128	14.671
220	18.914	23.373	14.882

230	19.966	23.552	14.976
240	22.039	23.937	16.093
250	22.090	24.187	16.121
260	23.151	24.529	17.163
270	24.188	24.638	17.172
280	25.474	25.397	17.264
290	25.632	26.213	17.275
300	27.703	26.791	18.334

C. Exercise intensity simulation results

A single group test was carried out to verify the application effect of the model in high-load training. Eighteen people took part in a fitness test of 100,000 people, each of whom had to draw 7ml of blood from their elbows before exercising and then immediately shake it for the test. The main observation indexes were measured before, during and after high-load training.

a) Study on the correlation between exercise load and heart damage

Two different methods were used to study the cardiac damage under different exercise loads. By comparing the correlation between high density exercise and heart damage in various exercise modes, the accuracy under various trial times was compared. The comparison results are shown in Figure 4.

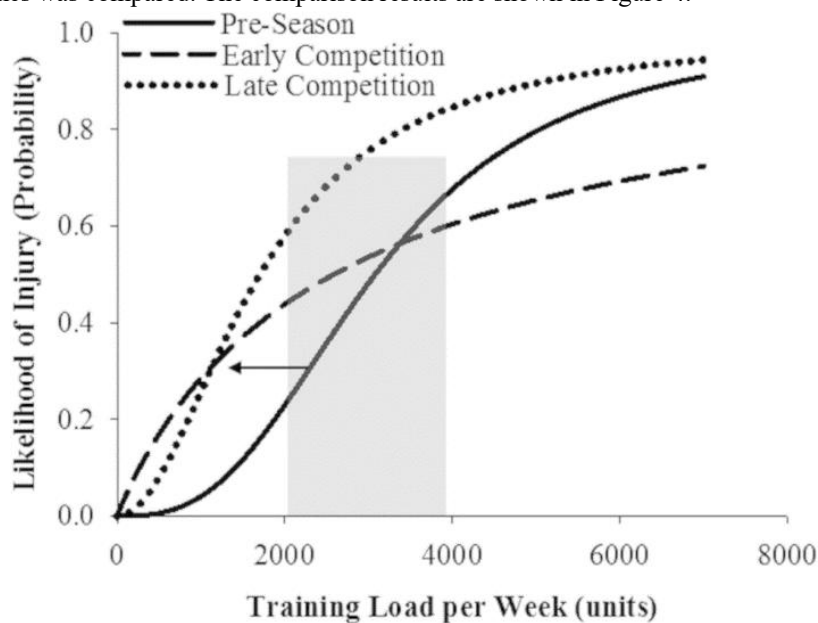


Fig.4: An accurate study of the effects of high-load training on cardiac damage in track and field athletes

As can be seen from Figure 4, under the same number of tests, the model built by this method can more accurately analyze the correlation between different exercise loads and heart damage than conventional calculation methods, and the advantages of this method will gradually appear with the increase of the number of tests. The analysis was 2.62 times higher than the conventional method.

b) Comparison of errors in studies on the correlation between high-load exercise and muscle damage

The improved algorithm and support vector machine were used to analyze the intensity training and myocardial injury of track and field athletes respectively. The error rates of the two methods under different number of tests are compared. You can see the results of the comparison in Figure 5.

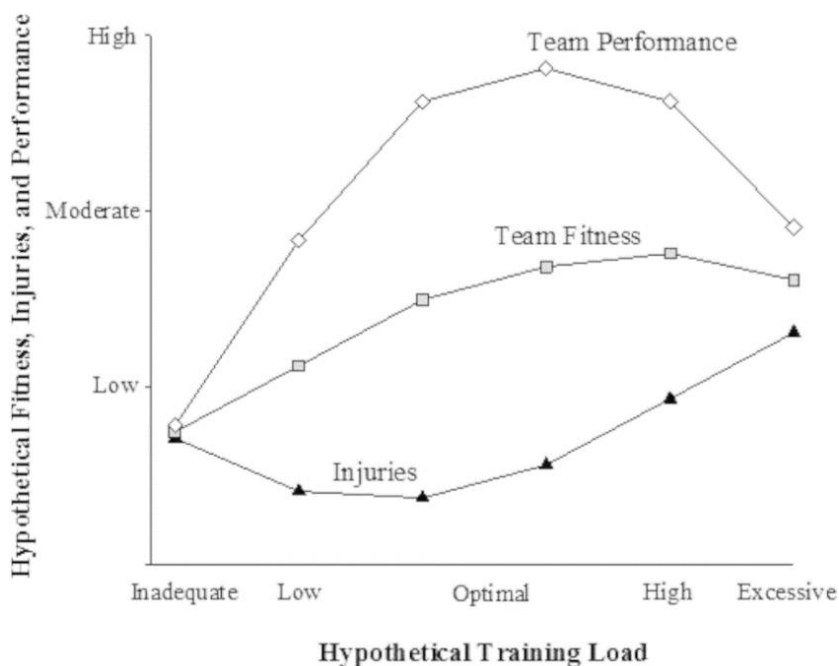


Fig.5: Comparison of errors in studies of the association between exercise load and cardiac damage

The results show that under the same number of experiments, the accuracy of the calculated results by this method is greatly reduced compared with the conventional method. In general, the prediction accuracy of the correlation between high-load training and heart damage is about 0.045%, while the conventional test results are only 0.193%, indicating that the calculation results of the algorithm have good accuracy.

c) Study on the correlation between exercise load and heart damage

The effectiveness, reliability and time complexity of the two methods are compared. The combined effect of the two methods was compared. You can see the results of the comparison in Figure 6.

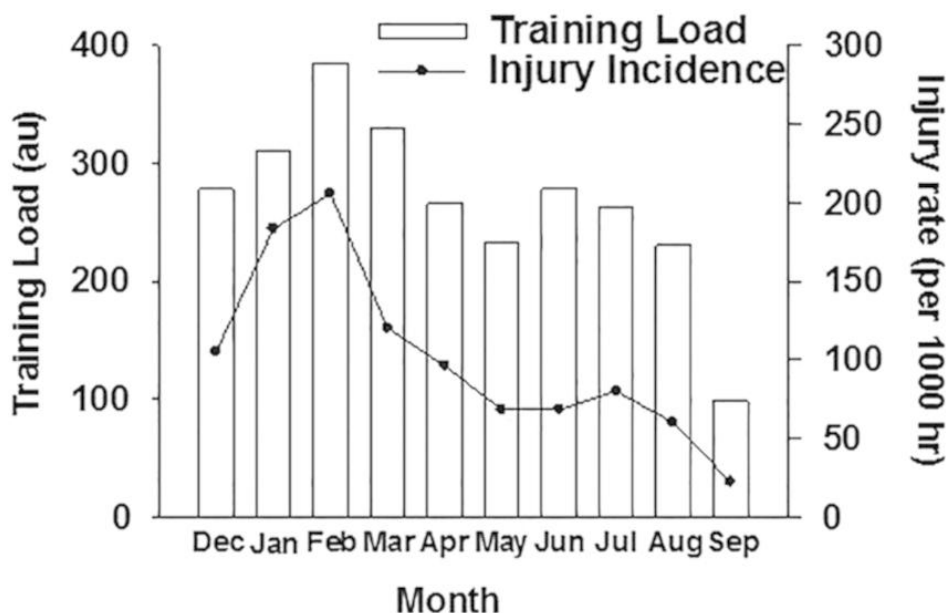


Fig.6: Analysis efficiency of the relationship between intensity training and myocardial injury by different methods

As can be seen from the analysis of Figure 6, under the same number of tests, the model built by this method can more effectively analyze the correlation between different exercise loads and myocardial damage, and the advantages of this method are becoming more and more significant. On the whole, the effectiveness of this method in predicting the correlation between strength training and myocardial damage reaches 97.54%. While the conventional method is only 78.25%, the prediction effect of this method is much better. The correlation between high-load training and myocardial damage is less complicated than the conventional model, and its

advantages are still significant with the increase of the number of tests. Overall, the reliability of the method for the correlation between high-load training and heart damage was around 0.221%, while the conventional method was only 0.621%, which indicates that the method has less time complexity in the calculation process and is easy to implement.

V. CONCLUSION

The research of this project can not only improve the athletic ability of sports training, but also expand the application of sports training, promote the digital development of sports training industry, and provide theoretical basis for theoretical research. An optimal model was established for the relationship between high-load training and cardiac damage. Through simulation experiments, the theory and method of this study were validated when studying the correlation between high-load training and heart damage. The results show that the model can effectively solve the existing problem of exercise load prediction.

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