Intelligent control model of athletes' training intensity based on big data analysis of physical fitness

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Abstract: Based on the analysis of big data, this paper designs the intelligent control model of sports athletes' training progress. By constructing the evaluation system of sports athletes' training intensity, it improves the intelligent control algorithm of sports athletes' training intensity, and ensures the operation effect of the intelligent control model of sports athletes' training intensity. In order to verify the effect of the model, simulation experiments are carried out, and the results show that most of the models are effective. From the perspective of analysis, the intelligent model of athletes' training progress has outstanding practical value. The model can quickly and accurately formulate training plans, solve the data fluctuation phenomenon under the trend of big data division, and realize intelligent operation. Moreover, the fluency and accuracy are very high, which is worth promoting and applying.

1. Introduction

As an important part of human activities, sports play an irreplaceable role in the development of human society. From the psychological point of view, people and animals have an inborn aggressiveness, but when people, as advanced animals, seek ways to vent their primitive aggression, they choose sports[1]. From the sociological point of view, whether it is the primitive society or the modern civilized society, competitiveness is one of the permanent symbolic characteristics. Because of the competition commonness between social activities and sports, people begin to transfer social competition to sports activities and find the right channel for them. Some people think that the basic function of sports is to release the aggressive impulse[2]. By making rules that people must abide by, people can learn to control their belligerent behavior. At the same time, sports are compared to social safety valve, which can alleviate international disputes and restrain social crimes. But sports itself has a strong competitiveness, if the management of sports is not good, it will also cause social problems[3]. For example, the fanatical development of competition in sports will evolve into court violence and so on. Therefore, the control of sports has become the key to social competitive transfer[4]. We should take sports as one of the tools to control social development, and use social management to control the operation of sports, so as to achieve win-win results. The traditional athlete training schedule planning system still has many shortcomings, especially the system terminal is difficult to timely and accurately process and analyze big data, resulting in slow implementation, which hinders the development of training schedule planning[5]. With the advent of the era of big data, big data analysis technology, based on advanced software system to collect and process data information resources, highlights its unique advantages, that is, covering massive data, high timeliness and practical value, strong accuracy and timeliness, and diversified output results, so it is favored in the intelligent planning of training progress[6]. Therefore, based on big data analysis, this paper designs an intelligent model of athletes' training progress, which can not only realize the real-time transformation of data analysis from manual to computer, experience to operation, but also significantly improve the timeliness and reliability of data
information processing, so as to provide effective guidance for athletes' training planning.

2. Intelligent control model of training intensity of sports athletes

2.1 Management of athletes' training intensity

For most sports, the impact of training on performance is greater than nutrition, equipment, mental state and other factors. Training, as a "double-edged sword", can not only bring performance to athletes, but also cause sports injury, overtraining and a series of diseases due to improper training, making athletes stop training or even unable to participate in the competition, so it is negative for training[7]. The quantification of charge becomes particularly important. In the actual training, coaches usually use the characteristics of training times, training time, training distance, training load weight to quantify the amount of training load. They use the speed, difficulty, height and load density to quantify the intensity of training load. At the same time, they also use the amount of load required to complete a certain intensity to quantify the training intensity. For coaches, accurate control of the overall load, load quality and quantity is the key to the success of training[8]. Therefore, accurate control of load intensity and quantity will make training more scientific; long term data accumulation will make training more systematic. Based on this, two aspects of quantitative training load are placed in the front of coaches and researchers. Through the overall framework of mesh program / server, mahsuh server is introduced to strengthen the linkage of each module[8]. The program also needs to respond to users in a timely manner, collect athletes' training demands information through data feedback, the server quickly counts and responds in a timely manner, and stores the data in the server-side database, so as to realize intelligent progress collection. The frame of the intelligent model for the training progress of sports athletes is shown in Figure 1.

![Fig.1 Intelligent model of training progress of sports athletes](image_url)

Big data mode is based on massive data collection and analysis to achieve, so in athlete training, data collection is an essential part of building intelligent model[9]. According to the training situation of athletes, data collection can choose two major technical links, namely identity system and interface. The big data collection process is as Figure 2:
In the process of reducing training, the effect of keeping the original training intensity is significantly higher than that of reducing the training intensity on the improvement of sports performance. It can be found that reducing training intensity has no effect on the improvement of sports performance in the period of reducing training, and its effect is only -0.02, P > 0.05; it can also be found that the effect of maintaining sports intensity in the period of reducing training is much higher than reducing training intensity\textsuperscript{[10]}. Because the competition time is fixed, the athletes' competitive state can be dynamically changed through comprehensive control, so that the athletes' competitive state is consistent with the competition time. After high-intensity training, there will be a temporary decrease in body function, but when it is converted to relatively easy training, there will be excessive recovery\textsuperscript{[11]}. The purpose of training adjustment is to make the peak state of athletes' body function coincide with the competition date by using excessive recovery. Under the suitable stimulation intensity, the muscle glycogen consumption in the body will increase with the increase of training stimulation intensity; in one stage of recovery period, the consumed substances will exceed the content before training, which is called excessive recovery\textsuperscript{[12]}. The degree of excessive recovery is closely related to the process of consumption. Within a certain range, the higher the consumption, the more obvious the effect of excessive recovery, that is, the more obvious the effect of pre competition training\textsuperscript{[13]}. Therefore, in pre competition training, coaches should take the principle of "excess recovery" as the scientific basis and adjust the training of athletes according to the characteristics of different athletes, so as to make athletes play the best competitive state in the competition. The basic flow of athlete training action evaluation model based on data mining is as Figure 3.
The original data needed by the model is the movement characteristic data of athletes, which is the reference data of evaluation. The tested athletes first register their accounts, log in to the model, input basic information, including gender, age, height and weight, position on the field, etc., and establish the athletes' files, which is conducive to the long-term training action evaluation and analysis. After that, the training movement data obtained by hardware equipment is automatically imported in the test process. After model evaluation and analysis, athletes can query their own evaluation results. The user setting part has permission settings, and the coach can view the evaluation results of all athletes, so as to adjust the training plan. The goal of strength training is related to sports, different stages of athletes, injuries and so on. The goal of strength training must be consistent with the physical condition of athletes, the training level of athletes, and the inherent needs of sports turn. In the strength training of explosive force and strength events, the goal of strength training is to increase the maximum strength. In the strength training of endurance events, the goal of strength training is to improve muscle endurance. In the adjustment period, the goal of athletes should be to improve muscle endurance and pave the way for the next high-intensity training; in the early stage of preparation, the goal should be to improve muscle volume and maximum strength; in the late stage of preparation, the goal should be to improve explosive force. In the early stage of rehabilitation, the goal of strength training is to improve muscle endurance and promote nerve control of muscle; with the progress of rehabilitation, the goal of strength training is gradually transferred to improving muscle strength, increasing muscle volume and explosive force. The common goals of strength training include: muscle endurance, muscle strength, muscle volume and explosive power. Strength is the ability to overcome or approach the maximum resistance. Speed is the ability of high-speed movement of limbs under no load or light load, such as high-speed swing racket, boxing, football shooting, etc. In strength training, it is more important to emphasize the speed of completing the action, rather than the resistance of strength training. When the resistance increases, the speed of completing the movement will certainly decline, so the auxiliary strength training of this kind of sports is mostly concentrated in the range of speed and speed strength. Speed power is the ability to accelerate the body or to obtain horizontal speed without the opponent's blocking, such as sprint, sprint, rapid direction change, etc. For the items that require high speed and strength, when carrying out strength training, we should not only emphasize the speed of completing the action, but also take into account the development of strength properly. The strength training of this kind of events is mostly concentrated in the range of speed strength and strength training. Explosive force is the ability to produce great force in all directions, or to overcome greater resistance or to produce greater thrust, such as long jump, high jump, blocking, etc. This kind of project in strength training should emphasize not only the speed of completing the action, but also the development of strength. The strength training of this kind of events is mostly concentrated in the range of speed strength, strength and strength speed.
refers to the ability to move heavy equipment or overcome or move opponents, or the ability to move at high speed under heavy load, such as judo, shot put, weight lifting, etc[18]. In strength training, it is more important to emphasize the development of basic strength and speed strength. Strength training is mostly concentrated in the range of strength and strength speed. When arranging the training, we should analyze the internal needs and characteristics of the project, determine the proportion of strength, explosive force, speed and other components in the continuum of continuous change, and highlight or give priority to the components closely related to the project needs on the basis of all-round development, which is more conducive to the improvement of sports performance and the prevention of sports injury[19]. In addition, whether it is speed based events or speed strength, explosive force, strength and speed based events, different types of sports have common characteristics in strength training, that is, training must emphasize the speed and quality of action. When the resistance remains the same, but the speed of completing the movement or the quality of completing the movement decreases, the training should be terminated.

2.2 Evaluation algorithm of athletes' training intensity

Sports training intensity includes two basic concepts: load and load intensity. In the correspondence teaching materials of physical education institutions, the load and load intensity are defined as follows: load intensity refers to the load stimulation of athletes' body in unit time or single (single group) action. Load refers to the extent of the internal response of the athlete's body to a certain amount of external stimulus during continuous and consistent physical activities. Load intensity reflects the amount of a certain exercise, a single action or unit time, and load is the sum of multiple intensity stimuli. Therefore, from this point of view, load intensity should be included in load. Load is actually the accumulation of load intensity in time during exercise, that is, load = load intensity × time.

In human movement, the greater the intensity of human movement, the greater the energy consumption in the human body. There is a direct proportion between the energy consumption and the intensity of human movement[20]. A mathematical expression can be expressed as: I=KE (where k is the proportional coefficient), and the energy consumption in the human body will inevitably cause changes in the working indexes of various organs and systems in the human body. Therefore, as long as we find out the physiological factors, we should pay attention to the relationship between the energy consumption and the intensity of human movement. According to the relationship between the index and training intensity, the corresponding exercise intensity can be calculated. At the same time, in physics, energy and work are the same dimension, and they can be transformed into each other, that is, the change of energy is equal to work, which can be expressed as E=FS by a mathematical expression:

$$I = KE = KFS$$ (1)

The load should be equal to K·F·S, and the average load intensity should be K·F·S/t (i.e. K·F·V). In physics, F·V is the concept of power. Through the above derivation, it is concluded that the load is actually work, and the load intensity is power. Load is the total intensity of the whole process of exercise, and load intensity is the instantaneous intensity in the process of exercise. In order to facilitate the research and assist the evaluation algorithm with modern technology, the data acquisition equipment is equipped with a wide-angle color camera, an infrared projector (infrared transmitter), a depth camera, four microphone arrays and other components. The wide angle color camera can rotate 360 degrees and adjust automatically according to the distance of the crowd. Microphone array can accurately locate the sound source and suppress the noise. The combination of infrared projector and depth camera constitutes the depth sensor of the device. In operation, the gray value of each pixel can get the depth value represented by the point, which is the vertical distance from the corresponding point of the tested athlete to the depth camera. The combination of these devices can accurately separate the athletes and the scene, separate the front and back scenes of the training field, and capture the three-dimensional data information of training actions from the athletes. The depth image acquisition uses the photon time-of-flight technology to obtain the plane distance s from the athlete to the infrared emitter:
In the formula, \( k \) is the speed of light, which is about \( 3 \times 10^8 \text{m/s} \), \( m \) is the frequency of modulated light (infrared projector), and \( \Delta \beta \) represents the phase difference between the transmitted light signal and the reflected light signal. Through this formula, we can get the depth value of the training field space, and get the three-dimensional position information of athletes. This technology is relatively stable, has strong ability of anti light interference, and the acquisition accuracy is greatly improved compared with traditional equipment. From the perspective of big data analysis, intelligent model is the most widely used. Its main feature is that it can effectively resist interference and ensure the accuracy and stability of model design. The intelligent model can make the model based on the collected data, and fully explain the characteristics of the analysis data. The intelligent model divides the data based on the coordinate system diagram, and constructs the characteristic data relationship through the normal distribution of the curve function. In order to realize the intelligent analysis of training progress data, an intelligent model is constructed:

\[
Q(k) = \frac{1}{N(k)M(k)} \left( \frac{Q(k)}{N(k)M(k)} \right)^{\alpha} \left( \frac{K(k)}{N(k)M(k)} \right) - \delta_h \left( \frac{G(E)}{N(T)} + \gamma \frac{Q(k)}{N(k)M(k)} \right)
\]

Among them, \( Q(k) \) is the data range, \( N(k) \) is the base height, \( M(k) \) is the working frequency, \( K(k) \) is the dynamic data model after the loss index correction, \( \delta_h \) is the transmission distance, and \( \gamma \) is the quantitative constant. Specific feedback data \( (H[a]) \) of intelligent model, namely:

\[
H[a] = \frac{\delta^2}{\partial y^2} \Omega = -\sum \epsilon_s w_i \xi_j \partial_l^{-1} \left\{ \sin \left[ \frac{\epsilon_i^{l/2}}{\xi} \right] \cos[\xi] \right\} e^{2l/2}
\]

Among them, \( V^2 \) is the delay parameter of athletes' training characteristics, \( \Omega \) is the effective use value of data, and \( \epsilon_s \) is the labeling operator. The specific feedback data of the intelligent model is the key link to further realize the intelligent planning of athletes' training progress. Through the above process, the preliminary construction of the model can be completed. Based on the construction of intelligent model, data transition is easy to occur in athletes' training data collection and intelligent feedback from the perspective of big data analysis:

\[
\frac{\delta^2 N_j}{\partial t^2} = \frac{(k-k_m-N_j)}{w_0(i)} > 0
\]

\[
\frac{\delta L_m}{\partial t} = \frac{(k-k_m-N_j)}{A + w_0(i) \pi} > 0
\]

Where, \( \delta^2 N_j \) is the average coefficient of model weight, \( k_m \) is the simulation index of model data, \( \delta t^2 \) is the best operation weight coefficient, \( W_0 \) is the big data expression attributes, \( A \) is the total amount of extreme data development process display. When the algorithm is modified, the robustness between modules will gradually decrease and the operation time will increase. Therefore, it is necessary to automatically adjust and optimize the operation process. The total amount shown in the two pole limit data is the limit value, the maximum and minimum values of the data can be determined after the optimization and adjustment, namely:

\[
G_f = \frac{R_j v_j}{[h_1, h_2, \ldots, h_p]} E_p \times \frac{X_j \times h_j \times v_j}{X_1, X_2, \ldots, X_p}
\]

Among them, \( E_p \) is the maximum critical value of the proposed total amount, \([h_1, h_2, \ldots, h_p] \) is the maximum value to the minimum value, which can collect the ordered set, and can calculate the best optimization bias of data, \([X_1, X_2, \ldots, X_p] \) is an ordered set of loss data. It is difficult to get a general formula of strength calculation by synthesizing the strength value of mechanics calculation.
and physiological and biochemical calculation, which will be a huge system engineering. The reason is that the dimensions of exercise strength reflected by various indexes are different, so they cannot be unified into one formula. By regression analysis between the load calculated by mechanics and that calculated by respiratory quotient, the general formula of strength calculation is as follows:

$$\sum_j = \int (aI_j + bE_s) \, dt \quad (8)$$

Among them, a and b are regression coefficients, which are 0.3 and 0.7 respectively. $E_s$ was mechanical and physiological loads. Through the formula, the intelligent model algorithm is modified and optimized to ensure the applicability and reliability of the targeted training schedule intelligent formulation.

### 2.3 Realization of intelligent control of athletes' training intensity

In the preparation cycle of sports training, athletes receive long-term and systematic training, including physical and technical training which has a great impact on sports performance. These training stimuli make athletes' sports system, such as: muscle system, cardiovascular system, nervous system, metabolic enzymes, morphology, movement structure and other indicators change to some extent, which are physiological and biological. The change brings about a series of changes in the state indexes of competitive ability, such as the increase of strength, faster speed, higher aerobic ability and higher output power, which eventually leads to certain changes in sports performance. Between the mechanism of sports performance acquisition, it can be simplified as the "dose response" model of the "dose" of training load stimulation and the "response" of sports performance or physiological adaptation type. This kind of "response" can be simply measured by sports performance, laboratory tests and physiological parameter changes. However, it is difficult to calculate the "dose" which has the greatest impact on "response", making it difficult to accurately obtain the "response" of sports performance or physiological parameter changes from the stimulation of "dose". Obviously, the physiological response brought by a single class or single action stimulation can be directly reflected, but a series of changes brought by long-term stimulation can not be reflected immediately. The lack of this intermediate link makes coaches and staff only rely on their own intuition and experience to judge the training load, which greatly reduces the work efficiency. At the same time, these methods are not very accurate, and this intuitive parameter is easy to cause differences in understanding among coaches, athletes and staff, so the emergence of an objective index becomes extremely important. Based on this, the intelligent control standard of athletes' training intensity is optimized as Figure 4:

![Fig.4 intelligent control standard of athletes' training intensity](image)

At present, many methods of quantitative exercise load are obtained through the "dose-response" model of sports performance. We can understand the "dose" by measuring the "response", and predict the "response" strength by the "dose". Of course, it is difficult to solve this problem only by coaches and trainers, because it involves many aspects, such as the injury problem caused by the total amount of exercise load, the overtraining problem caused by the total amount of exercise load, and the tactical
arrangement of many events, so an effective, reliable and standardised quantitative method will solve these problems.

Anaerobic endurance training is speed endurance training in the form of anaerobic energy supply, which aims to improve the ability of lactic acid energy supply system. In addition to aerobic endurance, excellent athletes should also have a certain foundation of anaerobic endurance in order to achieve better sprint effect in the final stage. Therefore, athletes not only need to have a high aerobic endurance, but also need to have a strong anaerobic endurance ability, so as to gain competitive advantage in the final key winning stage and win the final competition. Many coaches and athletes' training practice for many years shows that after high-intensity training, they can adapt to the stimulation of training and improve their performance. However, during this period, the accumulation of body fatigue caused by high-intensity training will be covered by physiological adaptation and good competitive state. In fact, their sports ability has not been improved ideally, which is common in training Phenomenon. The main purpose of pre competition training is to eliminate the physical and psychological fatigue of athletes and ensure the athletes to show the proper training effect in the competition. Pre competition tapering training: reduce the physiological and psychological pressure of athletes in the predetermined time, and at the same time continue to improve the physical adaptation and training adaptation of athletes, so as to promote athletes to reach the peak competitive state in time. Pre competition training is a process of excessive recovery. In this process, through the adjustment of training, we can eliminate fatigue, maintain abundant physical strength, and make some special preparations to meet the requirements of the competition, so as to create excellent results in the competition. Decrement training can increase the total number of red blood cells, hematocrit and hemoglobin, so the body's oxygen transport capacity can be improved to a certain extent, and the body can adapt to the training effect; decrement training will lead to the decrease of CK (creatine kinase) content and the recovery of body fatigue; Reasonable arrangement of training can reduce athletes' fatigue and improve their sleep quality when completing the same training load. It should be noted that it is not desirable and credible to judge the competitive state of an athlete only by a single index. Although the more intense the stimulation of training is, the more favorable it is to the over recovery of athletes' sports ability, it will inevitably lead to a greater degree of fatigue of athletes, and the deeper the stimulation is, the longer the fatigue elimination time will be, which is not conducive to the athletes' participation. Combined with the time of decrement training and fatigue level, competitive state, the overall health level, draw the relationship curve between them. In the process of decrement training, maintain high-intensity training, with the extension of time, fatigue level decreases rapidly, competitive state increases rapidly. However, if the reduction training lasts too long, there will be a downward trend of competitive state. Of course, if the reduction time is too short, the fatigue of the body will not be recovered, and the body will still be in a state of fatigue and will not show its due competitive state.

3 Analysis of experimental results

In order to verify the effectiveness of the intelligent control model of athletes' training intensity based on the analysis of physical fitness big data, the experiment was carried out. The athletes were selected as the experimental objects to simulate the training of the members of the competitive team, which was taken as the experimental samples. In order to ensure the effectiveness of the intelligent model experiment of athletes' training progress, as well as the stability and accuracy of the experimental process, the experimental data are set reasonably.

| Table 1 experimental data sheet |
|--------------------------------|
| frequency | 1 | 2 | 3 | 4 | 5 | 6 |
| Model feedback rate (%) | 32.4 | 46.0 | 57.8 | 64.7 | 77.9 | 90.4 |
| Training intensity | 0.16 | 0.30 | 0.38 | 0.49 | 0.55 | 0.68 |

In training, the body structure of athletes will not change, and will not be affected by height and
weight. The model selects three-dimensional spatial data of joints to identify the movement of athletes, and selects 15 joint points of left elbow, right elbow, left knee and right knee as the action tracking. Three states are set in the model to represent data acquisition, as shown in Table 2.

| Joint tracking status | Return value | significance                      |
|-----------------------|--------------|------------------------------------|
| track                 | 2            | Tracking, data available           |
| Conjecture            | 1            | Failed to get location, guessing   |
| fail                  | 0            | Failed to get data                 |

The main reference data of athletes' training action evaluation model is the content of athletes' action feature database. In order to determine the reasonable technical action, the athlete's action characteristic database should be set up by combining the power order, power law and many other techniques. Because each athlete's action range is different, there is no unified evaluation standard for technical action and posture, and each athlete's action will have a certain range of differences in completion. These differences will not affect the quality of service and the continuity of action, so they are also reasonable and effective. Different technical actions should be classified and extracted, and corresponding action feature tables should be established to form action feature database. So test software should be loaded on the model, which will not affect the model and the intelligence index pol in the perspective of big data analysis. The software evaluates the accuracy of data collection based on training indexes, and evaluates the model fit by using training parameters. The experimental results are shown in Figure 5.

![Fig. 5 Result Analysis of intelligent control of training intensity](image)

Based on the data, it can be seen that the pol index parameters of the model are relatively stable, always above 1.0. This intelligence can reach a high level of compliance, and the yuh index shows a gentle upward trend, which means that the feedback ability of the model is high. The data strength of the intelligent formulation model is shown in Figure 6.
Furthermore, the data acquisition equipment of training action evaluation model and the traditional equipment of training action evaluation model are installed in the same position of the training field. The tested athletes input personal basic information in the two models. The test lasted for four days, during which the athletes maintained normal training. The tested athletes use the traditional training action evaluation model and the proposed training action evaluation model to analyze and compare the error rate of the track information of the left forearm, the right forearm, the left leg and the right leg. The experimental demonstration results are shown in Figure 7.

![Fig. 7 Evaluation curve of joint changes of athletes](image)

It can be seen from the figure that the data strength of the intelligent model of athletes' training progress from the perspective of big data analysis is high, which can effectively reflect the degree of data basis. The more data is based on, the more accurate the result of the model is.

4. Conclusion
With the increasing pressure brought by social competition, sports has become the best choice for people to release pressure, and social pressure also turns to the field of sports, which plays a regulatory role in reducing social pressure. But sports contribute to reducing social pressure and increase their own burden. Therefore, for sports, we must make effective control of the pressure we bear. In competitive sports, many coaches and athletes suffer from social pressure because of people's excessive attention to competition results. For this reason, some coaches are eager for success in training in order to pursue competition results, and lack of the concept of reasonable control of key
links in the training process, which eventually leads to a large gap in the competition results of athletes. Through the research on the control of training intensity, it is found that, first of all, the reason for the negative effect of training intensity is not only that the coaches do not know enough about the training intensity, but also that the importance of training intensity control is blindly positioned, targeted deviation, reasonable wrong area and inaccurate mobility. Secondly, control plays a vital role in training intensity. If properly controlled, it will improve athletes' performance and maintain long-term; it will also reduce the risk of athletes' injury and psychological obstacles; it will also consolidate the relationship between coaches and athletes and greatly reduce the probability of contradiction. Finally, if the training intensity is controlled in the direction of "combination of competition and training", it will make the training intensity infinitely close to the competition intensity, or even exceed the competition intensity. Sports control is not only helpful to relieve social pressure, but also has the function of mediating contradictions and simplifying problems. Similarly, the control of training intensity also brings extraordinary benefits to improve sports performance, prolong athletes' sports life, and reconcile the relationship between coaches and athletes, which also reflects the value of control.

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