SWARM ALGORITHMS APPLIED TO FITNESS TESTING OF ATHLETES IN COMPETITION

ALGORITMOS DE ENXAME APLICADOS AO EXAME DO CONDICIONAMENTO FÍSICO DE ATLETAS EM COMPETIÇÃO

ALGORITMOS DE ENJAMBRE APLICADOS A LAS PRUEBAS DE APTITUD FÍSICA DE ATLETAS EN COMPETICIÓN

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ABSTRACT

Introduction: Many countries have increased their investments in human resources and technology for the internal development of competitive sports, leading the world sports scene to increasingly fierce competition. Coaches and research assistants must place importance on feedback tools for frequent training of college athletes, and deep learning algorithms are an important resource to consider. Objective: To develop and validate a swarm algorithm to examine the fitness of athletes during periods of competition. Methods: Based on the swarm intelligence algorithm, the concept, composition, and content of physical exercises were analyzed. Combined with the characteristics of events, the body function files and the comprehensive evaluation system for high-level athletes were established. Results: The insight was obtained that the constant mastery of the most advanced techniques and tactics by athletes is an important feature of modern competitive sports. Physical fitness is not only a valuable asset for athletes but also one of the keys to success in competition. Conclusion: Fitness has become an increasingly prominent issue in competition, and the scientific training of contemporary competitive sports has been increasingly refined. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Sports; Athletes; Exercise; Deep Learning.

RESUMO

Introdução: Muitos países aumentaram seus investimentos em recursos humanos e tecnologia para o desenvolvimento interno de esportes competitivos, levando o cenário esportivo mundial a uma disputa cada vez mais acirrada. Treinadores e assistentes de pesquisa devem dar importância às ferramentas de feedback para o treinamento frequente dos atletas universitários e os algoritmos de aprendizado profundo são um importante recurso a ser levado em consideração. Objetivo: Desenvolver e validar um algoritmo de enxame para examinar o condicionamento físico dos atletas em períodos de competição. Métodos: Com base no algoritmo de inteligência de enxame, o conceito, composição e conteúdo de exercícios físicos foram analisados. Combinado com as características dos eventos, os arquivos de funções corporais e o sistema abrangente de avaliação de atletas de alto nível foram estabelecidos. Resultados: Obteve-se a percepção de que o constante domínio das técnicas e táticas mais avançadas pelos atletas é uma característica importante dos esportes competitivos modernos. A aptidão física não é apenas um ativo valioso para os atletas, mas também uma das chaves para o sucesso nas competições. Conclusão: A aptidão física tem se tornado cada vez mais um problema proeminente na competição, sendo o treinamento científico dos esportes competitivos contemporâneos cada vez mais aperfeiçoado. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Esportes; Atletas; Exercício Físico; Aprendizado Profundo.*

RESUMEN

Introducción: Muchos países han aumentado sus inversiones en recursos humanos y tecnología para el desarrollo interno del deporte de competición, lo que ha llevado al panorama deportivo mundial a una competencia cada vez más feroz. Los entrenadores y asistentes de investigación deben dar importancia a las herramientas de retroalimentación para el entrenamiento frecuente de los atletas universitarios y los algoritmos de aprendizaje profundo son un recurso importante a tener en cuenta. Objetivo: Desarrollar y validar un algoritmo de enjambre para examinar el estado físico de los atletas durante los periodos de competición. Métodos: A partir del algoritmo de inteligencia de enjambre, se analizó el concepto, la composición y el contenido de los ejercicios físicos. En combinación con las características de los eventos, se establecieron los archivos de funciones corporales y el sistema de evaluación integral de los atletas de alto nivel. Resultados: Se obtuvo la conclusión de que el dominio constante de las técnicas y tácticas más avanzadas por parte de los atletas es una característica importante de los deportes de competición modernos. La forma física no sólo es un activo valioso para los deportistas, sino también una de las claves del éxito en las competiciones. Conclusión: La aptitud física se ha

convertido en una cuestión cada vez más importante en la competición, y el entrenamiento científico de los deportes de competición contemporáneos es cada vez mejor. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Deportes; Atletas; Ejercicio Físico; Aprendizaje Profundo.*

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INTRODUCTION

Due to the further socialization and commercialization of competitive sports, more and more countries begin to invest a lot of manpower and material resources to develop their own competitive sports, resulting in increasingly fierce competition in the world sports arena.[1] The action technology has reached a relatively perfect level, and the tactical system composed of various action techniques has been basically improved in all competitions.[2] The level of athletes' special physical fitness depends on their body shape, physiological function, sports quality and health level. In training, it is particularly important to monitor and feedback athletes' specific physical fitness.[3] Feedback information is the basic condition to achieve feedback control. Therefore, coaches and scientific research assistants must attach importance to obtaining various feedback information about the training of college athletes in peacetime training.[4] The scientific nature of the athlete's special physical training is characterized by the orientation of the special physical training content, the quantification of the training load and the individualization of the training process.[5] The ability to successfully cope with the consumption of physical energy under the fierce competition conditions has also become the basic guarantee for the team and team skills and tactics, and is also a prerequisite for the outcome of the game.[6] To achieve victory in sports competitions and achieve excellent athletic performance, physical fitness has become a particularly prominent factor.

The development of sports in China is relatively stable. In order to achieve good results and rankings in the competition, it is necessary to prepare for the special physical fitness before the competition.[7] In this article, we propose a research method based on swarm intelligence algorithm, which is aimed at the research on the application of special physical fitness during the athletes' competition.

In summary, our contributions are as follow:

1. The concept of group intelligence comes from the observation of insect groups in nature, and the macro-intelligence behavior characteristics of group-based organisms through collaboration.
2. Based on the swarm intelligence algorithm, this paper proposes a new model for the study of athletes' specific physical fitness.
3. This technology has achieved good accuracy in the study of the special physical fitness methods in the athletes' competition, and it has a high applicability for most of the athletes' special physical fitness research problems.

Related Work

Scholar Ehrnborg C also defines physical fitness, but his point of view is military. Military is added before physical fitness, literal understanding is the determination of the object of study. He believes that military physical fitness is the requirement that soldiers must be able to complete a high intensity in various special environments Haegele L E and Lucas J share slightly the same viewpoint, proposing that physical fitness is the most basic motor ability of all physical activities. The main influencing factors are body shape, function and quality, among which physical quality is the most decisive factor. It can be said that physical fitness refers to the sports ability of speed, strength, endurance, flexibility and agility. It includes the adaptability of the body and the speed, sensitivity and flexibility, endurance and strength of the quality.

MATERIALS AND METHODS

Modern sports training increasingly emphasizes the use of multi-disciplinary knowledge and methods to improve the abilities most needed by athletes in competition, starting from the rules of events. In sports training, it is necessary to strengthen the ability of athletes to bear heavy training load. Professional male athletes in China were selected as the research object. The basic information of athletes is shown in Table 1.

Table 1. Basic information of athletes.

Number of cases	Age	Weight (kg)	Height (cm)	Training period
20	24.8±3.2	75.1±5.7	178.9±3.6	5.5±0.7

Special physical training is an important part of training and the basis for improving athletic performance. In the whole process of training, coaches and athletes pay attention to the basic problem of nutrition. There are many recovery methods after training to meet the energy needs of athletes during training and competition. Explosive power is an important basis for sports programs to increase their speed. Various jumping training methods have a significant effect on improving the explosive power of athletes. The athlete's physical fitness is a complete system composed of multi-factor and multi-level structure.

Then the following formula can be obtained:

$$T_{cr} = 2A_0 t\left(0.33\sqrt{f_{ck}}\right) \tag{1}$$

$$\frac{A_t f_{yv}}{st} = 0.3\sqrt{f_{ck}} \tag{2}$$

$$\overline{V} = \int V \frac{dN}{N} \int_0^{\infty} Vf(V)dV = \sqrt{\frac{8RT}{\pi\mu}} \tag{3}$$

Due to the fierce competition in today's sports, in order to achieve good results, high-quality training is required for athletes, mainly in terms of long training time and high intensity. With the improvement of athletes' competitive level, the functions of various organs and systems of the body and the ability to cooperate between them have reached a very high level. If you encounter a player who is higher than your own level in the game, you must use active attack and tactics to compensate for technical or empirical deficiencies. Figure 1 shows the structural plasticity structure.

If you need to get two clusters, you only need to cut one of the longest edges. as shown in Figure 2.

The training content of physical training is mainly to solve the problem of what to practice. In modern competitive sports, the content system of physical training is an important guarantee for achieving physical fitness training goals. This paper proposes a modeling method based on swarm intelligence algorithm for athletes' biomechanical influence under training. Table 2 shows the power and fatigue index during the

repetitive anaerobic sprint run. Table 3 shows the relevant physiological indicators during the repetitive anaerobic sprint run.

In the whole process of training, coaches and athletes pay attention to the basic problem of nutrition. In order to meet the energy needs of athletes during training and competition, it helps to improve the body's immunity and keep athletes in a good competitive state. The classification of sports fatigue can be divided into rapid exercise fatigue and endurance exercise fatigue according to the difference between exercise mode and duration of exercise. Figure 3 shows the potential metabolic pathways being disturbed and the levels of important metabolites changing.

RESULT ANALYSIS AND DISCUSSION

The functional level of the body is the basic link of the physical structure. The functional level and state promote and restrict the physical exertion. Physical fitness is the concentrated embodiment of physical fitness. One of the difficulties for athletes to enter the stage of high-level training is that the plasticity space of competitive ability gradually decreases, and the speed of improving special performance gradually slows down. If the sports team can pay full attention to the usual physical training, to ensure that each player has a higher level of physical training. Physical fitness training can focus on the content and methods of comprehensive training, including the content of training activities and organization and arrangement. In tissue repair, cell proliferation relies on the regulation of growth factors to increase or inhibit the proliferation and proliferation of certain cells, and achieve the purpose of repair.

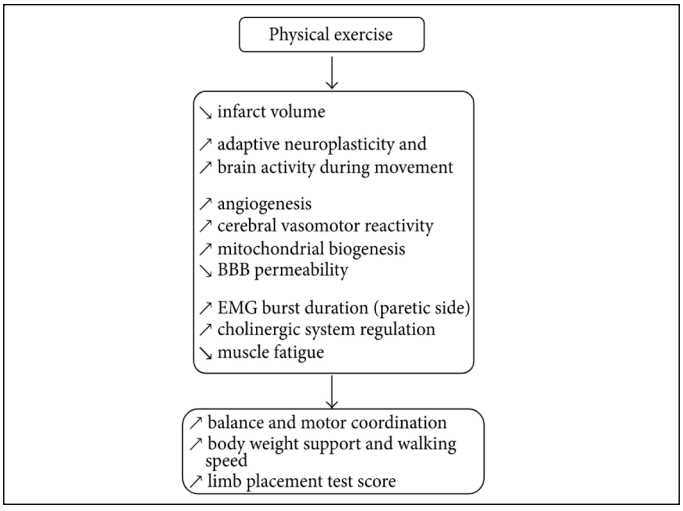

Figure 1. Movement function plastic structure.

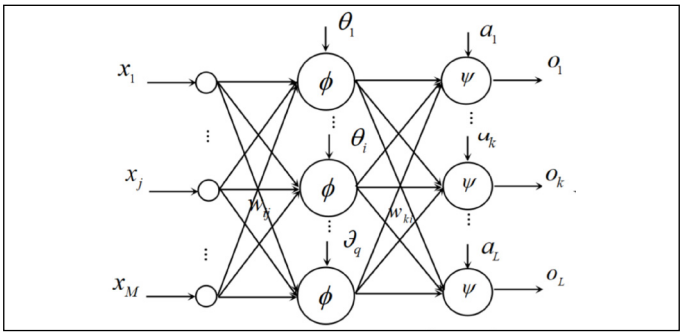

Figure 2. Spanning tree process.

Table 2. Power and fatigue index during repeated anaerobic sprinting.

Peak power (W)	Average power (W)	Minimum power (W)	Fatigue index
798.4	621.5	518.3	409.8

Table 3. Relevant physiological indicators during the process of repetitive anaerobic sprint.

Blood lactate (mmol/L)	Heart rate (b/min)	RPE
10.8	171.2	14.5

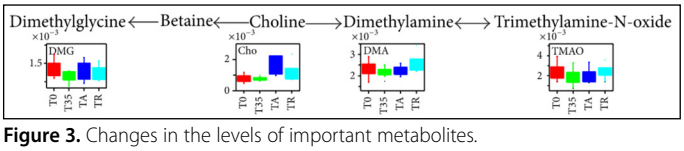

Figure 3. Changes in the levels of important metabolites.

Training should be in line with the game, which means that the purpose of training is to meet the needs of the game. In the practice of training, short-distance training is the mainstay, and the combination of long and short distances is organic. Exercises that last for a long time and have less intensity, such as preparing for activities. Mainly powered by the aerobic energy supply system, as the exercise time prolongs, the proportion of fat energy consumption gradually increases in the later period of long-term continuous exercise such as athletes' long-distance running aerobic exercises. The test results of each mechanical index before and after training were statistically analyzed. The experimental results are shown in Figure 4.

The training of speed ability centers on the speed of sports characteristics, and the improvement of athletes' absolute speed should be considered in the training arrangement. The training load is too small and the training load is too large for the improvement of sports ability. It can not only improve sports ability, but also damage the health of the body. Physical training refers to the behavior of athletes to improve or maintain the level of special competition under the guidance of the coach. Through the investigation of the time of sports injury to professional players. The injury of athletes is mainly caused during the exercise training, so the prevention and treatment of sports injuries is mainly during sports training. As shown in Table 4.

While properly arranging general physical training, special physical training must also be arranged reasonably. Any special item has special requirements for the body. The biomechanical characteristics of muscle meat under different training stages were extracted. Get muscle movement status at different training stages:

$$\sqrt{\overline{V^2}} = \sqrt{\frac{2RT}{\mu}} \tag{4}$$

Establish a muscle impact model under training:

$$V_p = \sqrt{\frac{3RT}{\mu}} \tag{5}$$

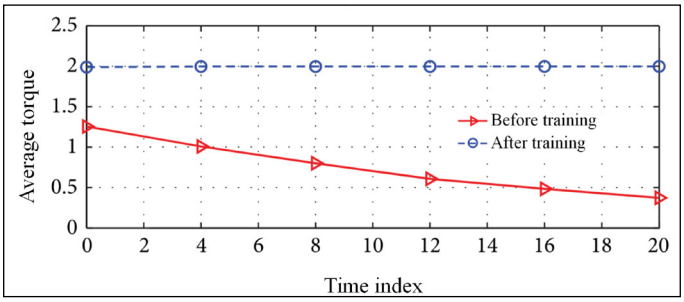

Figure 4. Comparison of average muscle strength between knees before and after training.

Table 4. Sports injury type data of athletes.

Number of people	Injury stage	Number of injured
30	Train	21
30	Match	6
30	Amateur	3

The muscle mechanical contraction mechanics model is:

$$PV = \frac{M}{\mu} RT \tag{6}$$

General physical training can not replace special physical training. As a new breakthrough in strength training, Super-equal-length training has a good effect on the improvement of speed and explosive force. Growth factors play three biological effects in the process of tissue repair, namely chemotaxis, synthesis, secretion and proliferation and differentiation. According to the changing trend of flexion angle and muscle force of athletes, the changes of three-dimensional motion angle and muscle force of knee joint in each analysis step are applied to the model as boundary conditions. As shown in Figure 5.

Timely understanding of athletes' fatigue and recovery after training is the result of training and competition. The performance plays a decisive factor. Make the output of the model best predict the output of the system and obtain an estimate of the parameter:

$$d\vec{B} = \frac{\mu_0 I d\vec{l} \times \hat{r}}{4\pi r^2} \tag{7}$$

The formula for calculating the integral myoelectricity is:

$$\vec{B} = \frac{\mu_0 I}{2\pi r} \tag{8}$$

The formula for calculating the rms amplitude is:

$$u_x = \frac{u_x' + v}{1 + \frac{v}{c^2} u_x'} \tag{9}$$

When arranging speed training, it is important to emphasize the quality of training and arrange speed training when the athletes are full of physical strength. The overall strength is the comprehensive strength of the athletes in the coordination of the various sports links in the special activities of the ball. The electromyogram values of the various stages of the subjects with different contraction patterns are shown in Figure 6.

The high degree of coordination of athletes greatly affects the quality of the movement and the improvement of the technical level. The failure of old sports injuries is the most important factor causing sports injuries. Athletes of different roles have different muscle strengths and flexibility. The curve of the position of the athlete's tibia in the global coordinate system with the knee flexion angle is shown in Figure 7.

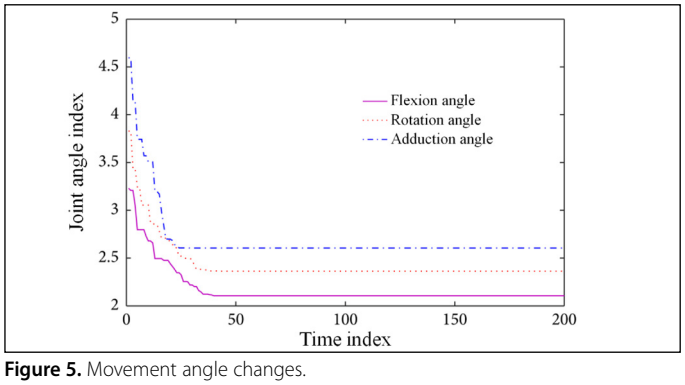

Figure 5. Movement angle changes.

The influence of the classifier recognition rate and the model order on the recognition rate is shown in Table 5.

The main external manifestation of special physical fitness is the special physical quality. Therefore, in the practice of training, it is usually necessary to adopt exercises that directly improve the special qualities. Speed endurance is the core content of sports training, and speed ability is the premise and foundation of speed endurance. Recognizing a project's characteristics is not just a simple unilateral understanding, but also requires multi-angle analysis and observation. Only in this way can we understand a project essentially. The overall strength training and the overall strength level are the development trend of the strength training of modern ball games. In the course of competition, athletes are always changing their speed. The use of competition tactics makes the whole course of competition possible to appear a process of constant acceleration. The speed and quality of mastering technical movements and the degree of consolidation and improvement depend to a great extent on the development and improvement of coordination ability.

CONCLUSIONS

Before deciding on an effective physical training program, first of all, it is necessary to clarify the determinants affecting athletes' specific technical ability. Athletes' physical fitness training includes strength, endurance, flexibility training and other general physical fitness training content. In training, we should not only pay attention to the skill training of athletes, but also strengthen the physical training of athletes. Especially the training of physical function, so that sports skills and physical fitness develop harmoniously, can improve sports performance. In the process of training, we

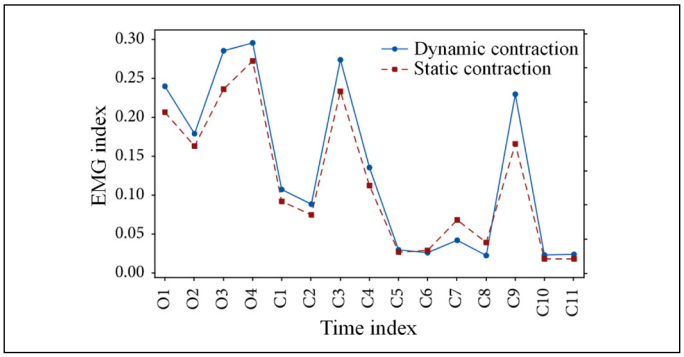

Figure 6. EMG values at various stages of the subject in different contractions.

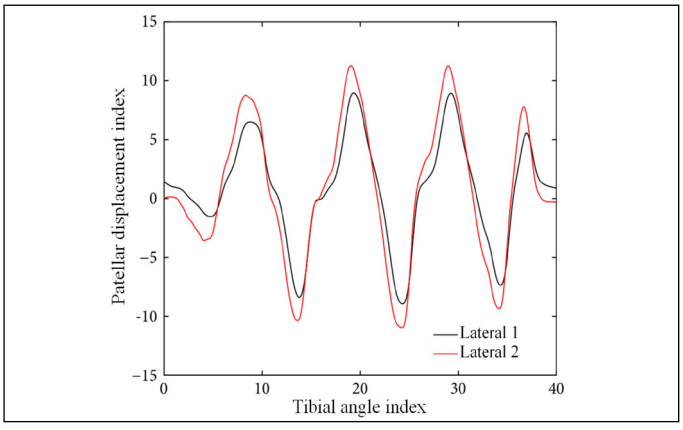

Figure 7. Changes in the angle of the patella to the knee flexion.

Table 5. Influence of model order on recognition rate.

Model order	20kg	25kg	35kg
2	73.63	84.69	85.63
4	80.52	80.35	86.59
7	74.46	86.51	87.15

should pay attention to the special speed training, strength and endurance training load should not be too large. Training should be combined with specific technical characteristics, and training should be carried out at a certain speed. The diagnosis of athletes' specific physical fitness includes situation diagnosis and gap diagnosis. The situation diagnosis includes overall situation diagnosis and individual situation diagnosis. In order to effectively improve the physical strength of the players, it is necessary to develop training methods from the two aspects of feasibility and effectiveness to strengthen the training of special endurance. For example, due to the incompleteness of the training program, the development of the trunk muscles is uneven, and even the joint deviation occurs. This can lead to irregularities in technical movements, and the chances of injury to joints and muscles of athletes are greatly increased.

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AUTHORS' CONTRIBUTIONS: The author has completed the writing of the article or the critical review of its knowledge content. This paper can be used as the final draft of the manuscript. Every author has made an important contribution to this manuscript. Each author has made important personal contributions to this manuscript. JY: writing and performing surgery.

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