LOAD PREDICTABILITY IN RESISTANCE TRAINING

PREVISIBILIDADE DE CARGA NO TREINAMENTO DE RESISTÊNCIA

PREDICTIBILIDAD DE LA CARGA EN EL ENTRENAMIENTO DE RESISTENCIA

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ABSTRACT

Introduction: With the continuous development of physical education teaching in colleges, the scientific method became essential for the best activity prescriptions, improving the training of the most diverse activities. However, resistance training in school physical education still lacks a scientific protocol. Objective: Scientifically determine the resistance training load of students and predict their sports results. Methods: This paper selected 30 student-athletes of athletics as research objects and designed the relevant resistance load training program for each athlete through the resistance load parameter table and the athletes' sports abilities and needs. At the beginning of week three, week six, and the end of the experiment, the data were measured, compared, and analyzed within the group. Results: The scientific resistance load training program can optimize the indexes such as blood lactate, maximal oxygen consumption, and heart rate stabilization during exercise, proving effective despite a certain deviation compared to the predicted value. Conclusion: According to the actual situation of athletes and the design of the table of exercise load parameters, it is believed that the determination and implementation of the resistance training program in athletes should receive further investigation, popularizing its use in other modalities. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Endurance Training; Resistance Training; Physical Education and Training.

RESUMO

Introdução: Com o contínuo desenvolvimento do ensino da educação física nas faculdades, o método científico tornou-se um aliado imprescindível para as melhores prescrições de atividades, aprimorando o treinamento das mais diversas atividades. Porém, o treinamento de resistência na educação física escolar ainda carece de um protocolo científico. Objetivo: Determinar cientificamente a carga de treinamento de resistência dos estudantes e prevendo os seus resultados esportivos. Métodos: Este trabalho selecionou 30 atletas estudantes de atletismo como objetos de pesquisa, projetou o programa de treinamento de carga de resistência relevante para cada atleta através da tabela de parâmetros de carga de resistência e as próprias habilidades esportivas e necessidades esportivas dos atletas. No início da terceira semana, na sexta semana e no final da experiência, os dados foram medidos, comparados e analisados dentro do grupo. Resultados: O programa científico de treinamento de carga de resistência pode otimizar os índices como o lactato de sangue, consumo máximo de oxigênio e estabilização da frequência cardíaca durante o exercício, provando ser eficaz, apesar de um certo desvio em comparação com o valor previsto. Conclusão: De acordo com a situação real dos atletas e o desenho da tabela de parâmetros de cargas de exercício, acredita-se que a determinação e a implementação do programa de treinamento de resistência nos atletas devem receber maiores investigações, popularizando o seu uso em outras modalidades. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Treino Aeróbico; Treinamento de Força; Educação Física e Treinamento.*

RESUMEN

Introducción: Con el continuo desarrollo de la enseñanza de la educación física en las facultades, el método científico se convirtió en un aliado esencial para las mejores prescripciones de actividades, optimizando el entrenamiento de las más diversas actividades. Sin embargo, el entrenamiento de la resistencia en la educación física escolar sigue careciendo de un protocolo científico. Objetivo: Determinar científicamente la carga de entrenamiento de resistencia de los estudiantes y prever sus resultados deportivos. Métodos: Este trabajo seleccionó 30 estudiantes atletas de atletismo como objetos de investigación, diseñó el programa de entrenamiento de carga de resistencia pertinente para cada atleta a través de la tabla de parámetros de carga de resistencia y las propias habilidades deportivas y necesidades deportivas de los atletas. Al principio de la tercera semana, en la sexta y al final del experimento, se midieron, compararon y analizaron los datos dentro del grupo. Resultados: El programa de entrenamiento con carga de resistencia científica puede optimizar los índices como el lactato en sangre, el consumo máximo de oxígeno y la estabilización de la frecuencia cardíaca durante el ejercicio, demostrando su eficacia a pesar de una cierta desviación respecto al valor previsto. Conclusión: De acuerdo con la situación real de los atletas y el diseño de la tabla de parámetros de carga de ejercicio, se cree que la determinación y aplicación del programa de entrenamiento de resistencia en los atletas debe recibir más investigaciones, popularizando su uso en otras modalidades. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Entrenamiento Aeróbico; Entrenamiento de Fuerza; Educación y Entrenamiento Físico.*

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INTRODUCTION

Nowadays, due to the change of the times and the development of sports, endurance training plays an increasingly important role in the training of athletes.[1] The quality of athletes' endurance is often closely related to their physical quality. In training, endurance training load is the superposition and accumulation of athletes in long-term endurance training.[2] This also means that the endurance of athletes is closely related to the intensity and time of endurance training.[3] In view of the diversity of sports based on endurance training load, such as track and field sports, ball games and swimming, these sports are closely related to the endurance training load of athletes.[4] If an excellent athlete wants to achieve good results in these sports and improve his competitive level, he should pay attention to the endurance training load in daily training. The endurance load of athletes is also divided into positive and negative loads, and there is also a flat load.[5] Positive and negative loads, as the name suggests, refer to the positive and negative effects on endurance of athletes in endurance training according to the amount of exercise. While the load is balanced, but the training level and time are kept unchanged during a period of training, resulting in neither positive growth nor negative growth of endurance level.[6] Sports prediction based on endurance training load will help to carry out different endurance training loads for different sports in future teaching and training, so that athletes can improve their muscle endurance and physical quality in training, so as to ensure that athletes maintain a good competitive state and achieve ideal results in competition.

METHOD

Firstly, this paper consulted a large number of data, made a detailed understanding of the current research on endurance training, and had a certain understanding of the sports performance prediction methods and the determination of relevant indicators. Then in the selection of research objects, in order to more intuitively explore the sports effect, this paper selects track and field athletes as the research object, and selects 30 track and field athletes according to the principle of voluntariness. The study and all the participants were reviewed and approved by Ethics Committee of Henan Institute of Economics and Trade (NO.21HNIET87-BZ). Using the method of intra group comparison, the related indexes of endurance and exercise were measured before the experiment. According to the frequency of 2 hours 10 times a week, it lasts for 9 weeks. During and after the training, the relevant indexes before the training were measured again.

According to the results of literature research, the load parameters are determined, as shown in Table 1.

In order to analyze the endurance training load design more systematically, this paper starts from the two aspects of athletes' relevant indicators and performance. Blood lactic acid, maximum oxygen uptake and stable heart rate during exercise were selected as the criteria for judging the relevant indicators of endurance training, and the results of 500 meter and 1500 meter running were taken as the criteria for judging the changes in sports performance. The data were measured and compared and analyzed within the group in the third week, the sixth week and the end of the experiment.

Table 1. Exercise load parameters.

Content		Master level	International elite
Preparation period	Aerobic metabolism running volume (%)	55~60	45~50
	Mixed metabolic running volume (%)	40~37	51~47
	Anaerobic metabolism running volume (%)	5~3	4~3
Competition period	Aerobic metabolism running volume (%)	50~55	40~45
	Mixed metabolic running volume (%)	38~35	46~43
	Anaerobic metabolism running volume (%)	12~10	14~12

RESULTS

The relationship between the measured value and the predicted value of related indexes in the course of endurance training

As shown in Table 2, after 3 weeks of endurance training, the measured blood lactic acid content was 14.1876 ± 0.1926 (mmol/l), slightly lower than the predicted value of 14.6365 ± 0.3836 (mmol/l), $P < 0.01$, indicating that there was a very significant difference; After 6 weeks of endurance training, the measured blood lactic acid content was 14.8832 ± 0.3683 (mmol/l), slightly higher than the predicted value of 14.7241 ± 0.2469 (mmol/l), $P < 0.05$, indicating that there was a significant difference; After 9 weeks of endurance training, the measured blood lactic acid content was 16.0490 ± 0.3934 (mmol/l), slightly higher than the predicted value of 15.2080 ± 0.3345 (mmol/l), $P < 0.05$, indicating that there was a significant difference. Blood lactic acid, in short, refers to the content of lactic acid in the blood. It is a by-product of the decomposition and energy supply of sugars in the body, including muscle glycogen and free glucose, under anaerobic conditions. To some extent, the higher the blood lactic acid content per unit time, the more energy the body provides. It can be seen from the results in Table 2 that the blood lactic acid content increased gradually during the experiment, which is in line with the description of the predicted value. In the range of change, the actual value of blood lactic acid after three weeks was significantly higher than the predicted value, and the difference was larger and larger. This shows that the change of the predicted value of lactate is less than the actual value in the process of research and training. Therefore, it is necessary to adjust the countermeasures appropriately to obtain better sports effects.

As shown in Table 3, after 3 weeks of endurance training, the measured maximum oxygen uptake value was 50.9681 ± 6.1825 (ml/kg/min), slightly lower than the predicted value of 52.8141 ± 6.3929 (ml/kg/min), $P < 0.01$, indicating that there was a very significant difference; After 6 weeks of endurance training, the measured maximum oxygen uptake was 51.8671 ± 7.3669 (ml/kg/min), slightly lower than the predicted value of 52.1603 ± 5.6289 (ml/kg/min), $P < 0.01$, indicating that there was a very significant difference; After 9 weeks of endurance training, the

Table 2. Relationship between predicted value and actual value of blood lactic acid during the experiment (mmol/l).

Options	Estimate	Actual value	P
3 weeks	14.6365±0.3836	14.1876±0.1926	P<0.01
6 weeks	14.7241±0.2469	14.8832±0.3683	P<0.05
9 weeks	15.2080±0.3345	16.0490±0.3934	P<0.05
P	P<0.05	P<0.01	——

Table 3. Relationship between predicted and actual maximum oxygen uptake during the experiment (ml/kg/min).

Options	Estimate	Actual value	P
3 weeks	52.8141±6.3929	50.9681±6.1825	P<0.01
6 weeks	52.1603±5.6289	51.8671±7.3669	P<0.01
9 weeks	53.6229±6.2839	55.4753±5.8028	P<0.05
P	P<0.05	P<0.01	——

measured maximum oxygen uptake was 55.4753 ± 5.8028 (ml/kg/min), slightly higher than the predicted value of 53.6229 ± 6.2839 (ml/kg/min), $P < 0.05$, indicating that there was a significant difference. Relatively speaking, the higher the maximum oxygen uptake value, the stronger the athlete's cardiopulmonary strength. From table 3, it can be seen that the actual value shows a significant increase trend, and significantly increased in the second half of the experiment, much greater than the predicted value, which also shows that the actual sports effect of athletes is higher than the predicted value, so the experimental effect is better.

As shown in Table 4, after 3 weeks of endurance training, the measured value of stable heart rate was 170.1917 ± 6.2839 (BPM), slightly lower than the predicted value of 176.8660 ± 7.2781 (BPM), $P < 0.01$, indicating that there was a very significant difference; After 6 weeks of endurance training, the measured value of stable heart rate was 167.4481 ± 5.7741 (BPM), slightly lower than the predicted value of 168.3040 ± 5.8264 (BPM), $P < 0.01$, indicating that there was a very significant difference; After 9 weeks of endurance training, the measured value of stable heart rate was 170.6225 ± 4.0325 (BPM), which was slightly higher than the predicted value of 165.4113 ± 6.6893 (BPM), $P < 0.05$, indicating that there was a significant difference. The stable heart rate during exercise, in short, means that the athlete's body adapts to this exercise intensity load, so the heart rate gradually becomes stable. It can be seen from the results in Table 4 that the athlete's heart rate measurement shows a fluctuating state, and the actual value in the third week and the ninth week has little difference, which shows an obvious contrast with the gradual decline in the predicted value, indicating that the current endurance training load still has great shortcomings in stabilizing the athlete's heart rate, which needs to be further adjusted.

The relationship between the measured value and the predicted value of sports performance in the course of endurance training

As shown in Table 5, after 3 weeks of endurance training, the measured result of 500m running was 90.9080 ± 3.7501 (s), and the time was slightly lower than the predicted value of 91.5036 ± 3.9341 (s), $P < 0.01$, indicating that there was a very significant difference; After 6 weeks of endurance training, the measured result of 500m running was 89.0004 ± 2.8870 (s), and the time was slightly higher than the predicted value of 86.5365 ± 3.4564 (s), $P < 0.05$, indicating that there was a significant difference; After 9 weeks of endurance training, the measured result of 500m running was 88.2283 ± 3.9341 (s), and the time was slightly higher than the predicted value of 85.7176 ± 3.3446 (s), $P < 0.01$, indicating that there was a very significant difference.

As shown in Table 6, after 3 weeks of endurance training, the measured result of 1500m running was 241.1297 ± 7.3988 (s), which was slightly lower than the predicted value of 250.9696 ± 5.3111 (s), $P < 0.05$, indicating that there was a significant difference; After 6 weeks of endurance training, the measured 1500m running performance was 235.3433 ± 5.7741 (s), and the time was slightly higher than the predicted value of 231.9893 ± 7.1102 (s), $P < 0.05$, indicating that there was a significant difference; After 9 weeks of endurance training, the measured result of 1500m running was 234.9001 ± 6.5897 (s), and the time was slightly higher than the predicted value of 225.6506 ± 4.9663 (s), $P < 0.01$, indicating that there was a very significant difference.

DISCUSSION

Endurance training load helps athletes to accumulate endurance training of body muscle groups through long-term training in training. Therefore, there are a variety of sports events for endurance training. At the same time, sports events based on endurance training load also put forward higher requirements for athletes' body muscle endurance. I think there are several sports based on endurance training load: the first is track and field. Track and field sports put forward higher requirements for athletes' muscle endurance, and also put forward higher requirements for athletes' muscle explosiveness. If athletes want to achieve good results in track events, they can maintain a good competitive state at the same time. In the endurance training load, the positive load of endurance training is required to achieve the purpose of positive improvement of muscle endurance. The second kind of sports is ball games. In ball games, whether basketball or football or other sports with a wide audience, which are carried out to a higher degree in China, they all put forward higher requirements for the endurance of athletes' sports muscle groups. In ball games such as basketball and football, it is a great test of the ability of sports mobilization to combine the endurance of muscles and people with the ball in long-term sports training or competition, This also requires athletes to improve muscle endurance in training, so as to achieve good competitive status in long-term training and competition. The third kind of sports is swimming. Because of its particularity, swimming puts forward higher requirements for the coordination ability of the body, the explosive power of muscle energy in the process of sports and the endurance of long-term sports muscle groups. Athletes should improve the positive load of their muscles in training, so as to achieve the effect of improving the endurance and explosive power of muscles.

Table 4. Relationship between predicted value and actual value of stable heart rate during exercise during experiment (BPM).

Options	Estimate	Actual value	P
3 weeks	176.8660±7.2781	170.1917±6.2839	P<0.01
6 weeks	168.3040±5.8264	167.4481±5.7741	P<0.01
9 weeks	165.4113±6.6893	170.6225±4.0325	P<0.05
P	P<0.05	P<0.01	——

Table 5. Relationship between predicted and actual results of 500m race during the experiment (s).

Options	Estimate	Actual value	P
3 weeks	91.5036±3.9341	90.9080±3.7501	P<0.01
6 weeks	86.5365±3.4564	89.0004±2.8870	P<0.05
9 weeks	85.7176±3.3446	88.2283±3.9341	P<0.01
P	P<0.01	P<0.05	——

Table 6. Relationship between predicted value and actual value of 1500m running performance during the experiment (s).

Options	Estimate	Actual value	P
3 weeks	250.9696±5.3111	241.1297±7.3988	P<0.05
6 weeks	231.9893±7.1102	235.3433±5.7741	P<0.05
9 weeks	225.6506±4.9663	234.9001±6.5897	P<0.01
P	P<0.01	P<0.05	——

CONCLUSION

It can be seen from the research in this paper that further optimizing the determination method of endurance load and selecting more appropriate endurance training indicators according to the actual situation of athletes can effectively improve the effect of endurance training and make athletes obtain better competitive results. Therefore, it is worth promoting. But relatively speaking, the experiment in this paper still has some shortcomings, that is, there is a certain deviation between the calculated results of the predicted values and the measured values of the experiment, which is mainly reflected in the fact that although there is a trend of performance improvement, the improvement range and rate are inconsistent with the actual measured results. Investigating the

reasons, the author thinks that there may be the following two factors: first, the interference and contingency caused by human training. In addition to daily training, 30 students also have a lot of personal learning and living time. Within these time ranges, if they show different actions, it is easy to cause the experimental results to be interfered by irrelevant variables, showing an error performance, As a result, the predicted value deviates from the actual value. Secondly, because sports is a project greatly disturbed by personal performance, the existing data calculation model can not better simulate the actual situation of sports, so there is a deviation between the predicted value and the measured value. However, in general, the research in this paper has made some progress, which also proves that the way of endurance load confirmation is worth popularizing.

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