PHYSICAL QUALITIES OF MODERN PENTATHLON ATHLETES IN TRAINING AT ALTITUDE

QUALIDADES FÍSICAS DOS ATLETAS DE PENTATLO MODERNO NOS TREINOS EM ALTITUDE

CUALIDADES FÍSICAS DE LOS ATLETAS DE PENTATLÓN MODERNO EN EL ENTRENAMIENTO EN ALTITUD

Original Article
Artigo Original
Artículo Original

Xiaoning Wang[1,2]
(Physical Education Professional)
Bizhen Lian[1]
(Physical Education Professional)

1. Beijing Sport University, China Basketball College, Beijing, China.
2. Shandong Agricultural University, School of Physical Education, Taian, Shandong, China.

Correspondence:
Bizhen Lian
Beijing, China, 100084.
wxnwxn2022@126.com

ABSTRACT

Introduction: Modern pentathlon has high requirements for the physical, psychological, and tactical training of athletes, and practicing the five items as a whole in physical training is a problem that needs to be solved. Organizing the load of each item and the overall load may be a circumventable problem using the altitude training technique. Objective: This study aimed to test and evaluate the effects of altitude training on modern pentathletes' athletic performance and functional status. At the same time, we analyzed the method's influence on the athletes' physical quality. The ultimate goal of this experiment is to improve the science of modern pentathlete training. Methods: Six athletes from the modern pentathlon team were selected as research subjects. Changes in physiological indicators of the test subjects before and after altitude training were recorded. Mathematical statistics were used to analyze the collected data. Results: The athletes' hemoglobin during high-altitude training was significantly higher than before training (P<0.05). Other physiological indicators such as blood urea and high-density protein were not significantly different (P>0.05). Modern pentathlon performance of athletes after altitude training was significantly improved (P<0.05). Conclusion: Altitude training can improve the performance of modern pentathlon athletes. At the same time, this training method can also improve the athletes' aerobic capacity. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Sports; Athletes; Altitude; Hemoglobins.

RESUMO

Introdução: O pentatlo moderno tem altos requisitos para o treinamento físico, psicológico e tático dos atletas e praticar os cinco itens como um todo no treinamento físico é um problema que precisa ser resolvido. Como organizar a carga de cada item e a carga geral pode ser um problema contornável utilizando a técnica de treino em altitude. Objetivo: Este estudo teve como objetivo testar e avaliar os efeitos do treino em altitude no desempenho atlético e no status funcional dos pentatletas modernos. Ao mesmo tempo, analisamos a influência do método na qualidade física dos atletas. O objetivo final deste experimento é melhorar a ciência do treinamento moderno de pentatletas. Métodos: Selecionou-se seis atletas da equipe moderna do pentatlo como objetos de pesquisa. Foram registradas as alterações nos indicadores fisiológicos dos sujeitos do teste antes e depois do treinamento de altitude. As estatísticas matemáticas foram utilizadas para analisar os dados coletados. Resultados: A hemoglobina dos atletas durante o treinamento em alta altitude foi significativamente maior do que antes do treino (P<0,05). Outros indicadores fisiológicos como ureia sanguínea e proteína de alta densidade não foram significativamente diferentes (P>0,05). O desempenho moderno do pentatlo dos atletas após o treinamento em altitude foi significativamente aprimorado (P<0,05). Conclusão: O treinamento em altitude pode melhorar o desempenho dos atletas modernos do pentatlo. Ao mesmo tempo, esse método de treinamento também pode melhorar a capacidade aeróbica dos atletas. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Esportes; Atleta; Altitude; Hemoglobinas.*

RESUMEN

Introducción: El pentatlón moderno tiene altas exigencias para la formación física, psicológica y táctica de los atletas y la práctica de los cinco ítems en conjunto en la formación física es un problema que necesita ser resuelto. La forma de organizar la carga de cada elemento y la carga global puede ser un problema que se puede evitar utilizando la técnica de entrenamiento en altitud. Objetivo: Este estudio tuvo como objetivo probar y evaluar los efectos del entrenamiento en altitud sobre el rendimiento deportivo y el estado funcional de los pentatletas modernos. Al mismo tiempo, analizamos la influencia del método en la calidad física de los atletas. El objetivo final de este experimento es mejorar la ciencia del entrenamiento del pentatleta moderno. Métodos: Se seleccionaron seis atletas del equipo de pentatlón moderno como sujetos de la investigación. Se registraron los cambios en los indicadores fisiológicos de los sujetos de prueba antes y después del entrenamiento en altitud. Se utilizaron estadísticas matemáticas para analizar los datos recogidos. Resultados: La hemoglobina de los atletas durante el entrenamiento en altitud fue significativamente mayor que antes del entrenamiento (P<0,05). Otros indicadores fisiológicos como la urea en sangre y la proteína de alta densidad no fueron significativamente diferentes (P>0,05). El rendimiento del pentatlón moderno de los atletas

tras el entrenamiento en altitud mejoró significativamente (P<0,05). Conclusión: El entrenamiento en altitud puede mejorar el rendimiento de los atletas de pentatlón moderno. Al mismo tiempo, este método de entrenamiento también puede mejorar la capacidad aeróbica de los atletas. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Deportes; Atletas; Altitud; Hemoglobinas.*

DOI: http://dx.doi.org/10.1590/1517-8692202329012022_0352 Article received on 06/07/2022 accepted on 07/15/2022

INTRODUCTION

Modern pentathlon originated in Europe. In 1912, the 5th Olympic Games modern pentathlon began to be included in the official competition. Modern pentathlon includes five events: shooting, fencing, swimming (200m), equestrian, and cross-country (3km). The project is a comprehensive movement of collective energy, technology, psychology, and intelligence.[1] The project combines movement and stillness, coexisting with courage and elegance. It is loved by the masses abroad. China began to carry out modern pentathlon in 1981. Chinese male and female athletes have achieved good results in Asia. Both male and female athletes were awarded Olympic tickets. This has achieved zero breakthroughs in the history of the Chinese Olympic Games. We arrange the athletes to perform altitude training to observe the changes of some physiological and biochemical indicators of the athletes.

METHOD

Research objects

We selected a total of 6 athletes for the modern pentathlon team. There were three male players, with an average age of 21.5±1.9 years, an average height of 182.7±4.5cm, and an average weight of 77±3.2kg. The average training period was 6±1.8 years. Three female players.[2] The mean age was 21±1.4 years. The average height was 171.5±4.4cm. The mean body weight was 61.3 ± 9.7 kg. The average training years was 1.9 ± 0.6 years.

Research methods

We monitor hemoglobin and blood urea weekly. Ten items were monitored after the training session and the following day.[3] Body fat and body weight were monitored on the 2nd and 50th days of the plateau.

The physical function fatigue limit model of modern pentathlon

This paper proposes a modern five physical function fatigue limit monitoring method based on extensive data fusion analysis of body function characteristics.[4] The machine learning prediction function for the detection of the associated features of the fatigue limit of modern five physical functions is:

$$F_j = \sum_{k=1}^{n} x_k \times z_k \tag{1}$$

We construct modern pentathlon physical function fatigue limit associated feature distribution vector sets.[5] The fuzzy membership function of the associated characteristic data of the fatigue limit of modern five physical functions is:

$$P_F = \sum_{j=k}^{N} \sum_{u_i=j} \prod_{i=1}^{N} (P_{fi})^{u_i} (1-P_{fi})^{1-u_i} \tag{2}$$

$$P_D = \sum_{j=k}^{N} \sum_{\sum u_i=j} \prod_{i=1}^{N} (P_{di})^{u_i} (1-P_{di})^{1-u_i} \tag{3}$$

P_{fi} represents the fusion cluster center of the associated feature data of modern pentathlon physical function fatigue limit. P_{di} is the fuzzy association rule set. We use statistical analysis methods to evaluate physical function fatigue characteristics.[6] In this way, the analysis model of the correlation characteristics of the fatigue limit of modern five physical functions is obtained:

$$\Lambda_0 = \{\beta \in \Gamma : \left|\left\langle f, d_{\gamma_0} \right\rangle\right| \geq a, \sup_{\gamma \in \Gamma} \left|\left\langle f, d_{\gamma} \right\rangle\right|\} \tag{4}$$

We analyze the model to obtain the distribution of quantitative characteristics associated with the fatigue limit of modern five physical functions:

$$h(t) = \sum_i a_i(t) e^{j\theta_i(t)} \Lambda_0 \tag{5}$$

Output a subsequence of associated data:

$$X = [X_\alpha(0), X_\alpha(1), \cdots X_\alpha(N-1)]^T \tag{6}$$

According to the above analysis, we construct an analysis model for physical function fatigue response characteristics.[7] We combined the regression analysis method to monitor the fatigue limit of the modern pentathlon. In this way, we construct the corresponding feature analysis model of physical function fatigue.

There is no need for a code of ethics for this type of study.

RESULTS

Changes in hemoglobin

The modern pentathlon team members performed 31 hemoglobin monitoring in the plains.[8] We counted and calculated the average and compared it with the average of 9 monitoring in the plateau training phase. The study found that the hemoglobin in the plateau stage was significantly higher than that in the plain (P<0.05). The average increase in individual hemoglobin was 0.9 g/dl. The increased range is 0.5-1.8g/dl.

Changes in blood urea

The mean monitoring data in the blood urea plain was compared with the mean monitoring data in the plateau training phase.

Table 1. Hemoglobin plateau data control g/dl.

	Individual mean before training	Plateau training phase mean
1	12.0±0.6	12.6±0.26
2	13.0±0.59	14.2±0.53
3	12.3±0.60	12.9±0.36
4	14.0±0.96	15.0±0.51
5	13.9±0.90	15.2±0.46
6	14.6±0.60	16.6±0.50

(Table 2) The study found no difference in blood urea value between plain and plateau.

The blood urea of men's plateau training on the 12th day was slightly lower than that on the 5th day and then increased by different amplitudes every week. This value peaked on the 40th day of altitude training.[9] The index subsequently declined. Low blood urea was maintained until the end of altitude training. The women's blood urea level started to rise from the 5th day. The change curve is similar to that of men.

Changes in body fat

During the plateau training, we observed the changes in body fat and weight of the female players.[10] We used the difference between the measured values on the 2nd and 50th days of the plateau as the changes in body fat, body weight, and lean body mass during the plateau training period. (Table 3)

DISCUSSION

The modern pentathlon team has four pieces of training in shooting, swimming, fencing, and cross country. The training plan is as follows: 5-day adaptive training for beginners in the upper plateau. The athlete then performed a 3-week training volume. Rhythmically increase the intensity and focus on increasing the training volume. The athlete then adjusts for a week.[11] Then the amount of training for a week is slightly reduced. Athletes highlight intensity with interval training. According to the monitored index results, a specific training load is reduced after the athlete completes the weekly plan. The intensity of the final week increased, but the completion requirements decreased.

The impact of high altitude on the human body is mainly due to lower oxygen partial pressure. Most studies show that high altitude training can lead to different degrees of increase in the body's hemoglobin.[12] In our observation, we also found that the hemoglobin of the team members in the plateau was significantly higher than that in the plain, and the increased range was 0.6-1.9g/dl. EPO is transported through the blood to hematopoietic tissues such as bone marrow. This promotes the differentiation of cells of the hematopoietic lineage of the bone marrow. Nucleated red blood cells divide, megaloblastic cells are formed and released. This enhances iron uptake and accelerates hemoglobin synthesis.

The average hemoglobin value of the modern pentathlon team in the plateau was significantly higher than that in the plain. This is related to the increase of EPO and the vigorous production of red blood cells and hemoglobin in the plateau. At the same time, the hemoglobin remained stable or increased during the training with increasing load for the three weeks before going to the plateau. Another factor that affects the fluctuations in RBC and Hb levels during altitude training is altitude dehydration. The hemoglobin value of the team members on the 3rd day when they first went to the plateau was much higher than the average value of the plain. This may result from the combined effect of many factors, such as hemoconcentration caused by high altitude dehydration, low adaptive training load, and increased EPO secretion. Throughout the plateau training phase, we pay attention to supplementation nutrients such as sugar, iron, protein, and vitamins. This also helps keep hemoglobin high. The female players subjectively drank too little water, and the 3d hemoglobin value was too high. The difference in training load schedule makes it challenging to infer the connection between the two. The impact of altitude training on the body needs more in-depth research and discussion.

A comparison of the mean blood urea during training at plain and at altitude found no difference. Altitude training has little effect on blood urea. The deepening of altitude training and the increase of training volume lead to a continuous increase in blood urea. The blood urea was still rising after the week adjustment from the 25th to the 33rd day. There are many factors affecting blood urea. An essential factor is to take into account the impact of diet. High-protein meals can lead to elevated blood urea levels. One week after the Spring Festival, the load was the largest, and the blood urea value also reached the peak value. After the monitoring data comes out, the coach makes some adjustments to the next week, the 40th to 47th day of altitude training. The blood urea decreased after the training week, and the hemoglobin increased.

During altitude training, female athletes' body fat, body weight, and lean body mass decreased. Some people believe that altitude training leads to the decline of skeletal muscle mass. This may be mainly due to hormonal changes in protein synthesis. Decreased protein synthesis and decreased skeletal muscle mass resulted in insufficient muscle strength and decreased speed qualities, which are adverse effects of altitude training. Remind us to pay attention to the supplement of protein on the one hand and to strengthen the arrangement of strength and quality classes on the other hand.

We chose to observe the urine indicators of athletes after high-intensity classes. Urine protein changes significantly. But the team members returned to normal the following day. Individual team members are sensitive to changes in urobilinogen. Urobilinogen is a product of hemoglobin catabolism in the body. The bilirubin produced by the body's daily hemoglobin, which is released by the destruction of red blood cells, is converted into bilirubin by the liver. It is finally reduced to urobilinogen into the small intestine and excreted in the feces. Some of it is absorbed into the liver and reused to synthesize hemoglobin. The urobilinogen value of our teammates in the morning urine was lower than the value after the training session. The players felt good subjectively, and the hemoglobin did not drop. This indicates that the player is in good functional condition. The team's strength class urine indicators are very responsive. We have stepped up our monitoring of him to prevent overtraining.

Table 2. Changes in blood urea plateau plain control mmol/L.

	Individual mean before training	Plateau training phase mean
1	6.3±3.35	6.5±0.7
2	5.35±0.84	5.33±0.93
3	7.5±3.28	7.36±2.36
4	5.46±3.24	5.39±3.86
5	8.36±3.06	8.98±3.34
6	6.32±0.89	5.87±3.46

Table 3. Changes in body weight and body fat of female players during plateau training.

Body fat loss/%	Weight loss/kg	Lean body mass loss/kg
0.40±0.21	2.45±0.65	1.44±0.81

ACKNOWLEDGMENT

The study was partly supported by Guizhou Province Philosophy and Social Science Planning Project, Name: Research on the High-Quality Development Path of Guizhou Sports Characteristic Town during the "14th Five-Year Plan" Period, No.: 20GZYB19.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. XW: writing; BL: data analysis, article review and intellectual concept of the article.

REFERENCES

1. Okhrimenko I, Pavlyk O, Tomenko O, Rybalko P, Cherednichenko S, Gvozdetska O, et al. Dynamics of Indicators of Cadets' Physical Development and Functional Status during Pentathlon. Int J Hum. Mov Sports Sci. 2021;9(4):814-23.
2. Godbout P, Nadeau L. A physical activity practice index for older students and adults. AJSPO. 2021; 8(2):99-120.
3. Han D. Exploring the organic harmony of the Modern Pentathlon of sports. Journal of the Korea Society of Computer and Information. 2020;25(8):99-109.
4. Andrey AS. American expansion, Russian threat and active democracy: An institutional perspective on triathlon history. Terra Economicus. 2021;19(3): 105-120.
5. Reale RJ, Roberts TJ, Lee KA, Bonsignore JL, Anderson ML. Metabolic rate in adolescent athletes: the development and validation of new equations, and comparison to previous models. Int J Sport Nutr Exerc Metab. 2020;30(4):249-57.
6. Csurilla G, Gyimesi A, Kendelényi-Gulyás E, Sterbenz T. Where is victory most certain? The level of luck-based noise factor in Summer Olympic Games. Acta Oecon. 2021;71(3):369-86.
7. Yasar OM, Turgut M. Mental toughness of elite judo athletes. Acta Med. 2020;36(2): 995-8.
8. Pinto MS, Sánchez C, Martins N, Menegaldo LL, Pompeu F, de Oliveira LF. Effect of Achilles Tendon Mechanics on the Running Economy of Elite Endurance Athletes. Int J Sports Med. 2021;42(12):1128-36.
9. Jin W, Yanhong S. Investigating Tactics Characteristics of Mass-Start Event of Speed Skating in Pyeongchang Winter Olympics. Rev de Psicol del Deporte (Journal of Sport Psychology). 2021;30(2):263-72.
10. Erdağı K, Tüfekçi O, Yeşeri M, Raif Ö, Başol M, Deveci EM. The Examination of Relationship Between Anthropometric Measurement Values of Lower Extremity and Weightlifting Performance of Olympic Style Weightlifting Athletes. Türkiye Spor Bilimleri Dergisi. 2021;4(1):1-8.
11. Hilaiel SC, Alsulan MSA. The Effect of a Training Curriculum Using High-Intensity Functional Training (HIFT) on Some Physical Abilities and Scoring Accuracy for Futsal Football Players. Ann Romanian Soc Cell Biol. 2021;25(6):19652-61.