MONITORING PHYSIOLOGICAL AND BIOCHEMICAL INDICES IN THE SYSTEMATIC TRAINING OF SPRINTERS

MONITORAMENTO DE ÍNDICES FISIOLÓGICOS E BIOQUÍMICOS NO TREINO SISTEMÁTICO DE VELOCISTAS

MONITOREO DE LOS ÍNDICES FISIOLÓGICOS Y BIOQUÍMICOS EN EL ENTRENAMIENTO SISTEMÁTICO DE VELOCISTAS

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Xiangkun Li[1]
(Physical Education Professional)
Ting Li[1]
(Physical Education Professional)
Yihan Zeng[1]
(Physical Education Professional)

Yunnan University, School of Physical Education, Kunming, China.

Correspondence:
Yihan Zeng
Kunming, China, 650504.
lixiangkun12320@163.com

ABSTRACT

Introduction: This paper studies physiological and biochemical indicators in the systematic training of sprinters. This paper analyzes the data measured during the athletes' training process and studies the detailed data of their physical functions. Objective: This study aimed to find a link between exercise data and biochemical indicator data in sprinter athletes. By analyzing the data from this article, the researchers were able to find the optimal training program for the athletes. Methods: High-intensity aerobic training tests were performed with statistical analysis of various physiological and biochemical indicators. Results: Hemoglobin data were shown to be highly sensitive to intensity. The researchers found that long-term high-load training in athletes can lead to physical fatigue. This fatigue production is positively correlated with the intensity of the training load. Conclusion: There is a strong positive correlation between biochemical and physiological indicators on performance levels in sprinter athletes. ***Evidence Level II; Therapeutic Studies – Investigating the results.***

Keywords: Track and field; Athlete; Physiological monitoring; Sports.

RESUMO

Introdução: Este artigo estuda o monitoramento de indicadores fisiológicos e bioquímicos no treino sistemático de velocistas. Este documento analisa os dados medidos durante o processo de treino das atletas e estuda os dados detalhados de suas funções físicas. Objetivo: O objetivo deste estudo foi encontrar uma ligação entre os dados de exercício e os dados de indicadores bioquímicos nas atletas velocistas. Ao analisar as informações deste artigo, os pesquisadores conseguiram encontrar um programa de treino ideal para as atletas. Métodos: Foram empegadas experiências de treino aeróbico de alta intensidade, com análise estatística de vários indicadores fisiológicos e bioquímicos. Resultados: Os dados de hemoglobina mostraram-se altamente sensíveis à intensidade. Os pesquisadores descobriram que o treino a longo prazo de alta carga em atletas pode acarretar numa fadiga física. Essa produção de fadiga está positivamente correlacionada com a intensidade da carga de treino. Conclusão: Há uma forte correlação positiva entre indicadores bioquímicos e fisiológicos nos níveis de desempenho em atletas velocistas. ***Nível de evidência II; Estudos Terapêuticos - Investigação de Resultados.***

Descritores: *Atletismo; Atleta; Monitorização Fisiológica; Esportes.*

RESUMEN

Introducción: Este trabajo estudia el seguimiento de los indicadores fisiológicos y bioquímicos en el entrenamiento sistemático de los velocistas. Este artículo analiza los datos medidos durante el proceso de entrenamiento de los atletas y estudia los datos detallados de sus funciones físicas. Objetivo: El objetivo de este estudio fue encontrar una relación entre los datos del ejercicio y los datos de los indicadores bioquímicos en los atletas velocistas. Al analizar las informaciones de este artículo, los investigadores pudieron encontrar un programa de entrenamiento óptimo para los atletas. Métodos: Se realizaron pruebas de entrenamiento aeróbico de alta intensidad con análisis estadístico de varios indicadores fisiológicos y bioquímicos. Resultados: Los datos de la hemoglobina se mostraron muy sensibles a la intensidad. Los investigadores descubrieron que el entrenamiento de alta carga a largo plazo en los atletas puede conducir a la fatiga física. Esta producción de fatiga está positivamente correlacionada con la intensidad de la carga de entrenamiento. Conclusión: Existe una fuerte correlación positiva entre los indicadores bioquímicos y fisiológicos en los niveles de rendimiento de los atletas velocistas. ***Nivel de evidencia II; Estudios terapéuticos - Investigación de resultados.***

Descriptores: *Atletismo; Atleta; Monitoreo Fisiológico; Deportes.*

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INTRODUCTION

The author tracks, monitors, and analyzes the biochemical indicators of female sprinters at different training stages.[1] Indicators include serum testosterone, serum cortisol, serum creatine kinase, urea nitrogen, hemoglobin, and so on. This study provides a scientific and objective basis for timely adjustment of training intensity, adjustment of the training plan, and further training guidance.

METHOD

Research object

The women's track and field team have four special 400m and 4×400m relay, athletes. The average age is 25.50±2.08 years, the height is 166.75±2.75cm, the weight is 50.25±1.71kg, and the professional training period is 8.25±1.28 years.

Research methods

We use photoelectric colorimetry to determine hemoglobin. The urea nitrogen was determined by the urease method.[2] Serum testosterone and cortisol were measured by radioimmunoassay. Serum creatine kinase was determined by the enzyme kinetics method.

We selected seven comprehensive test data of female sprinters before the official competition.[3] The sampling times were January 25, March 25, April 22, May 20, June 20, July 12, and August 9. The fasting venous blood collection time is from 6:30 to 7:00 in the morning.

Co-evolutionary algorithm of the physiological two-way regulation mechanism

The cross probability P_{c_m} of the main group, the cross probability P_{c_a} of the auxiliary group A, and the cross probability P_{c_b} of the auxiliary group B all increase with the decrease of the main group search index $\alpha(i)$, namely

$$P_{c\_j} = P_c^0[1+\varepsilon_j(R(\alpha(i)) - S(\alpha(i)))], j = a,b,m \tag{1}$$

P_{c_j} and P_c^0 are the real-time crossover probability and the initial crossover probability, respectively. ε_j is a real factor and it is necessary to ensure that P_{c_j} is not greater than 1. The mutation probability P_{m_m} of the main group, the mutation probability P_{m_a} of the auxiliary group A, and the mutation probability P_{m_b} of the auxiliary group B all increase with the increase of the main group search index $\alpha(i)$, namely

$$P_{m\_j} = P_m^0[1-\phi_j(R(\alpha(i)) - S(\alpha(i)))] \tag{2}$$

P_{m_j} and $P^0_{m\_j}$ ($j = m, a, b$) are the mutation probability and the initial mutation probability, respectively. j is a real factor, and its function is similar to ε_j. The change rule of the individual exchange probability between the auxiliary group A, B is

$$\gamma = \gamma^0[1-\psi(R(\alpha(i))) - S(\alpha(i)))] \tag{3}$$

γ^0 and ψ are the initial exchange probability and real factor, respectively. By comparing formulas (1) to (3), it can be found that the enhancement and suppression factor is $R(\alpha(i))$ - $S(\alpha(i))$. It is easy to get by formulas (2) and (3)

$$R(\alpha(i)) - S(\alpha(i)) \begin{cases} > 0, \text{当} 0.7 \le \alpha(i) < 1.0, \\ \approx 0, \text{当} 0.5 \le \alpha(i) < 0.7, \\ < 0, \text{当} 0.0 \le \alpha(i) < 0.5. \end{cases} \tag{4}$$

The coordinated control level can coordinately adjust the crossover and mutation probability and the exchange probability between search groups in real-time according to the change of the search index $\alpha(i)$ of the main group.

Data statistical processing

The research data were statistically processed with SPSS15.0 statistical software. Each data is expressed as mean±standard deviation (M±SD). The independent sample T-test was used to test the significance of the differences between the groups.[4] P<0.05 means the difference is significant, P<0.01 means the difference is very significant.

RESULTS

Hemoglobin (Hb)

The four athletes of the women's sprint team have relatively stable Hb values throughout the training period. Only on May 20 and July 12, it was lower than the results of other tests (P<0.05). This shows that the amount of Hb decreased due to increased exercise intensity in the middle of training and the final sprint. But relative to women, the average is still at a high level of normal. The shorter the time required to recover under the same conditions, the higher the training level and the stronger the function mobilization of athletes. Current research believes that athletes with Hb index should be at a level above normal.[5] It will help athletes to play sports. From this perspective, the monitoring and adjustment of the hemoglobin indicator have achieved the expected goals. (Table 1)

Blood Urea (BUN)

During the entire training period, the BUN values of the four 400-meter female athletes were all within the normal range, and there was no significant difference between the groups (P>0.05). This shows that the amount of exercise is arranged very scientifically during the whole preparation period.[6] Athletes are better able to adapt to the amount of exercise. The BUN value measured on May 20 was lower than that measured at other times. This shows that the athlete's body is better adapted to the amount of exercise at this stage. The Hb value measured on May 20 did have a significant decrease compared with the previous stages (P<0.05). It shows that the athlete's body is not adaptable to the amount and intensity of exercise.

Serum testosterone (T), serum cortisol (C)

The serum testosterone values on April 22, June 20, and the last test before the National Games on August 9 were significantly higher than the

Table 1. Comparison of hemoglobin, urea nitrogen, blood testosterone, cortisol, and creatine kinase during training (n=4).

Index	HB (g/dl)	BUN (mmol/L)	T (ng/mL)
1/25	142.75±12.04	4.45±1.16	41.25±4.8
3/25	143±11.86	5.33±1.55	46.07±7.72
4/22	143±8.18	5.23±0.81	51.27±8.55
5/20	137.67±6.66	3.7±0.67	37.78±4.38
6/20	141.25±12.6	4.83±0.96	49.45±11.54
7/12	136.75±8.22	4.33±1.03	40.15±7.65
8/9	141.5±9.98	5.01±0.82	51.38±3.16
Index	C (ug/dl)	T/C	CK (U/L)
1/25	21.6±3.55	1.94±0.3	129.75±40.97
3/25	21.67±2.19	2.16±0.55	128.33±41.02
4/22	22.90±6.01	2.29±0.39	144.67±73.51
5/20	20.53±4.91	2.77±0.65	115.5±29.14
6/20	18.6±3.51	2.69±0.58	105±19.48
7/12	18.58±5.4	2.3±0.77	205.5±68.99
8/9	18.1±5.32	2.17±0.52	121.75±24.85

level at the beginning of the full training on January 25 (P<0.05). It shows that the athletes can better adapt to the whole exercise volume and intensity.[7] The serum cortisol level has been relatively stable throughout the preparation period. There is no significant difference between the values of each stage (P>0.05). It shows that the body's catabolism is at a very reasonable level.

Serum Creatine Kinase (CK)

The "training value" of serum CK mainly reflects the body's stress to the size of the exercise load. "Recovery value" can better reflect the body's adaptation to the training load and recovery status after training. Our research results show that the value of serum creatine kinase (CK) during the entire training phase increases first and then decreases.[8] It has been relatively constant at a relatively low level. At present, it is a reasonable range for female athletes to reduce serum creatine kinase activity to below 300IU/L in the morning quiet. This perspective shows that the body is more adaptable to the training plan during the preparation period before the National Games. No serious physical damage occurred.

DISCUSSION

Hemoglobin (Hb) is the main component of red blood cells. Hemoglobin can assess the physical function status of athletes and reflect the iron deficiency status in the body.[9] It is the basic index to evaluate an athlete's nutrition and health status. Its main function is to act as a carrier for red blood cells to transport oxygen and CO_2 and maintain blood acid-base balance and a constant pH value. Therefore, it directly affects the body's physical functions and exercise capabilities. Regularly measuring the content of hemoglobin helps to understand the athlete's nutrition, function, and health status.

Blood urea is the final metabolite of tissue and cell amino acid catabolism, and it is also a classic sensitivity index reflecting skeletal muscle protein metabolism in sports medicine.[10] The balance of energy metabolism in muscles is disrupted. The catabolism of protein and amino acids is strengthened, and the increase in urea production leads to an increase in blood content. Therefore, blood urea nitrogen can be an important indicator to reflect the degree of body fatigue and evaluate the functional status. There are three main changes in blood urea concentration: (1) The blood urea concentration remains unchanged every morning during training. This shows that the exercise load is small, and it cannot cause enough stress in the body. (2) The blood urea concentration rises at the beginning of training and gradually returns to normal. This shows that the amount of exercise is large enough for the body to adapt. (3) The blood urea concentration remains high throughout the training cycle. This shows that the amount of exercise is too large, and the body is in incomplete recovery. At this time, you should pay attention to adjusting the amount of exercise. Otherwise, it is easy to cause excessive fatigue.

The effect of testosterone on exercise is mainly to stimulate the increase of protein synthesis in the body, which promotes erythropoietin production. Regulate the excessive recovery of muscle glycogen white after exercise and increase glycogen reserves. Maintaining offensive awareness makes athletes more hard-working and enterprising in competitions.[11] Reduce body fat, increase muscle volume and strength, etc. 25% of testosterone in women comes from the synthesis of ovarian mesenchymal cells and hilar cells and the reticular zone of the adrenal cortex. The rest is mainly converted from androstenedione in the liver, fat, skin, and other tissues. The blood testosterone level in women is about 1/10 of that in men. Cortisol is a glucocorticoid secreted by the adrenal cortex. It is synthesized in the mitochondria of adrenal cortex cells and secreted into the blood. Under normal circumstances, about 200mg is secreted daily. Its biological function is to participate in material metabolism, and it is an important hormone that promotes the body's catabolism.

Creatine kinase is also called phosphocreatine kinase. 96% of creatine kinase is stored in human skeletal muscle. It is one of the key enzymes of skeletal muscle energy metabolism.[12] It is closely related to energy metabolism in the athlete's body. It is involved in the control of glycolysis, mitochondrial respiration, and muscle contraction. It is also one of the key enzymes in the body's ATP-CP functional system metabolism. It is generally believed that the higher the activity of serum creatine kinase, the greater the exercise intensity. Serum creatine kinase mainly comes from skeletal muscle and myocardium. The normal static value ranges from 10 to 100 units/L for men and 10 to 60 units/L for women.

CONCLUSION

The athlete's function monitoring is more successful during the whole training period. This laid the foundation for a good result in the final game. The extensive use of HB, BUN, T, C, CK and other indicators have strong practicability and pertinence for assessing the physical function level of female sprinters.

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