WORKLOAD CHARACTERISTICS IN THE FITNESS TRAINING OF CHINESE ATHLETES

CARACTERÍSTICAS DA CARGA DE TRABALHO NO TREINAMENTO DE CONDICIONAMENTO FÍSICO DE ATLETAS CHINESES

CARACTERÍSTICAS DE LA CARGA DE TRABAJO EN EL ENTRENAMIENTO FÍSICO DE ATLETAS CHINOS

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ABSTRACT

Introduction: In modern gymnastics, there are high demands for the physical quality of Chinese athletes. Objectives: This paper mainly studies whether the workload of Chinese gymnasts can support the corresponding high-intensity training in the training process. Methods: Experimental scientific research methods and statistical analysis are used to conduct a long-term study on dozens of gymnasts in Chinese schools and draw the workload curves of these gymnasts during gymnastic exercises. We try to determine the effective correlation between the athlete's body load and physical training and body shape. Results: During the training of gymnasts, heart rates can briefly exceed 190 beats per minute. Conclusion: In the training process of different gymnasts, the gymnasts' heart rates show obvious differences. Therefore, the use of scientific and reasonable training strategies can effectively improve the ability of athletes' hearts to withstand high-intensity exercise loads and help improve the gymnast's performance. ***Level of evidence II; Therapeutic studies - investigation of treatment results.***

Keywords: Gymnastics; Athletes; Workload; Sports.

RESUMO

Introdução: Há altas exigências para a qualidade física dos atletas chineses na ginástica moderna. Objetivos: Este trabalho tem como principal estudo verificar se a carga de trabalho dos ginastas chineses pode suportar o correspondente treinamento de alta intensidade no processo de treinamento. Métodos: Foram utilizados métodos de investigação científica experimental e análise estatística para efetuar um estudo de longo prazo sobre dezenas de ginastas nas escolas chinesas além de desenhar as curvas de carga de trabalho desses ginastas durante os exercícios. Tentamos determinar a correlação efetiva entre a carga de trabalho e o treinamento físico do atleta e sua forma corporal. Resultados: Durante o treinamento de alta intensidade dos ginastas chineses, os batimentos cardíacos puderam exceder brevemente os 190 batimentos por minuto. Conclusão: No processo de treinamento de diferentes ginastas, os batimentos cardíacos dos ginastas apresentam diferenças óbvias. Portanto, o uso de estratégias de treinamento científicas e razoáveis pode efetivamente melhorar a capacidade do coração dos atletas afim de suportar cargas de exercício de alta intensidade e ajudar a melhorar o desempenho do ginasta. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Ginástica; Atletas; Carga de Trabalho; Esportes.*

RESUMEN

Introducción: La calidad física de los atletas chinos en la gimnasia moderna es muy exigente. Objetivos: El estudio principal de este trabajo es comprobar si la carga de trabajo de las gimnastas chinas puede soportar el correspondiente entrenamiento de alta intensidad en el proceso de entrenamiento. Métodos: Se utilizaron métodos de investigación científica experimental y análisis estadísticos para llevar a cabo un estudio a largo plazo sobre docenas de gimnastas de escuelas chinas, además de dibujar las curvas de carga de trabajo de estas gimnastas durante los ejercicios. Intentamos determinar la correlación efectiva entre la carga de trabajo y el entrenamiento físico y la forma del cuerpo del atleta. Resultados: Durante el entrenamiento de alta intensidad de las gimnastas chinas, las frecuencias cardíacas podían superar brevemente las 190 pulsaciones por minuto. Conclusión: En el proceso de entrenamiento de diferentes gimnastas, las frecuencias cardíacas de las gimnastas muestran diferencias evidentes. Por lo tanto, el uso de estrategias de entrenamiento científicas y razonables puede mejorar eficazmente la capacidad cardíaca de las atletas para soportar cargas de ejercicio de alta intensidad y ayudar a mejorar el rendimiento del gimnasta. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Gimnasia; Atletas; Carga de trabajo; Deportes.*

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INTRODUCTION

Modern gymnastics requires athletes to have a good body shape and requires athletes to have a superb functional level and comprehensive athletic ability.[1] There are many reports on the body shape of gymnasts in China, but the research on function is still insufficient. In particular, articles reflecting the relationship between gymnasts' form, function, and physical training are rare.

In the past few years, we have tracked, tested, and studied the body shape and function of Chinese outstanding gymnasts. In this way, I tried to explore the relationship between gymnasts' body shape, functional characteristics, and physical training.[2] The purpose is to improve the physical fitness level of gymnasts and lay a theoretical foundation.

METHOD

Research object

Twenty first-line members of the national gymnastics team (including 14 team members and 6 individual members).

Research methods

Morphological function test method

Starting from 2019, we will carry out tracking tests on the body shape and function-related indicators of Chinese outstanding gymnastics collective and individual athletes.[3] We respectively measured various indicators of the athlete's body shape and function during the adjustment and training periods. The morphological indicators include length, circumference, and body fullness. Functional indicators include test indicators for multiple items of physiology and biochemistry (blood and urine testing).

Mathematical Statistics

We use a computer to perform mathematical statistics on the measurement data and perform relevant analysis on the statistical results.

Computer-aided analysis of exercise load

In the initial stage of developing the exercise load evaluation computer analysis system, a quantitative module of exercise load intensity was developed. The main function of this module is based on the athlete's main event distance and best performance.[4] The calculation method is derived from some simplified modifications based on the existing calculation formula.

$$R_{x(B)} = R_{1.0(A)}\left(\frac{L_B}{L_A}\right)^{1+K_{B/A}}(x\%)^{-K_{x(B)}} \quad (1)$$

$R_{x(B)}$ is the percent strength score on distance L_B. $R_{1.0(A)}$ is the full strength performance in the main distance. L_A and L_B are the lengths of the two distances. $K_{x(B)}$ is the power index to find the percent intensity on the distance L_B. $K_{B|A}$ is the power index of distance L_A versus distance L_B.

Results

The height and body length fully demonstrate the physical advantages of gymnasts

Tests have shown that the physical shape of Chinese gymnasts is taller, longer limbs, greater distance between fingers than height, shoulder width and narrow pelvis, long hands, high arches, long Achilles' tendons, and other characteristics (Table 1). This fully demonstrates the physical advantages of gymnasts.[5] At the same time, this also laid the foundation for forming difficult and beautiful sports skills and adaptive physical training for gymnastics.

The height of the body index reflects the symmetry and graceful curves of the gymnast

Chinese gymnasts have a larger index of finger spacing and length of upper and lower limbs, while sitting height and height are smaller. Queenlet index, Berwick index, and bust/height index are smaller.[6] The Achilles tendon of gymnasts is longer. (Table 2) The gymnast's body index shows the high level of symmetry of the athlete's body shape. This has great advantages for performing the aerial beauty of gymnastics and the formation of difficult movements.

Body composition and body mass index are the basis of agility and coordination of gymnasts

The body fat percentage and body mass index of the top gymnastics players in China is low, and the muscle content is relatively high. (Table 3) This is in line with the requirements of gymnastic skills for athletes' body shape. On the one hand, the low body fat content makes the athlete lighter, which is convenient for maneuvering the body flexibly and taking advantage of the aerial movement. On the other hand, gymnastics requires athletes to be beautiful. If fat accumulates, it will be bloated.

Changes in hematological indicators in athletes' physical training

The hemoglobin value of Chinese elite gymnasts fluctuates between (121-125) g·L^{-1} (Table 4). After heavy physical training, the hemoglobin value drops and can only recover after a few days. It can be seen that the hemoglobin level of gymnasts is at the critical value of sports anemia no matter when it is at rest or after physical training.[7] The hemoglobin of individual athletes is only 100g·L^{-1}, and the highest hemoglobin of athletes is only 138g·L^{-1}. Although many studies believe that hemoglobin will decrease during physical training with a large amount of exercise, the

Table 1. Body shape characteristics of Chinese elite gymnasts.

Project	$\bar{x} \pm s$
Finger spacing	169.97±22.78
Leg length	97.53±14.4
shoulder width	36.47±1.87
pelvis	25±2.7
Hand length	17.96±0.72
Instep high	4.04±0.83
Long Achilles tendon	27.9±3.02

Table 2. Body Shape Index of Chinese Excellent Gymnasts.

Project	$\bar{x} \pm s$	Project	$\bar{x} \pm s$
Finger distance/ height×100	101.7±12.3	Pelvis width/ shoulder width×100	68.60±2.01
Upper limb length/ height×100	44.05±0.99	Heel key length/ calf length×100	59.11±3.04
Sitting height/ height×100	50.63±1.20	Queenlet Index	274.91±19.50
Leg length/ height×100	58.51±2.40	Warwick Index	71.85±11.25
Shoulder width/ height×100	21.81±0.70	Pelvis width/ height×100	14.95±0.53

Table 3. Body composition measurement table of Chinese elite gymnasts.

Project	$\bar{x} \pm s$
Muscle content/Kg	40.09±2.51
Fat content/Kg	6.48±1.71
Body fat/%	12.8±2.50
Water content/%	29.95±1.86
Body mass index	17.5±9.00

decrease of hemoglobin will greatly impact athletes' athletic ability. This suggests that dietary compensation, nutritional supplements, and recovery promotion measures should be used in physical training to restore the athlete's hemoglobin in time. Otherwise, it will affect athletic ability.

Both blood testosterone and estradiol are at low levels of normal values. Blood testosterone levels drop after heavy physical training. Studies have shown that the levels of the two hormones are stable when they are functioning well. If the amount of exercise is too large or the athlete is tired, the blood testosterone level will drop drastically. The content of major and trace elements (mainly iron, magnesium, calcium, zinc) are also at the lower limit of the normal value (Table 5).

Changes in basic heart rate and blood pressure in athletes' physical training

Many studies have reported that long-term exercise training can reduce heart rate and blood pressure. The tested gymnasts' heart rate is between (50-60) times·min^{-1}, and their blood pressure is 13-15/7-9kPa. After heavy physical training, the athlete's heart rate and blood pressure increased, the heart rate increased (3-5) times·min^{-1}, the blood pressure increased (1-1.5) kPa, both of which were within the normal range of change, return to the original level within a week. (Table 6) It can be seen that the basic functional state of the athletes is very stable, showing a good state of reduced heart rate and blood pressure when the elite athletes are at rest.

Table 4. Comparison of hemoglobin, blood urea, creatine kinase, blood testosterone, and estradiol in different periods of athletes.

	HB(g·L^{-1})	BUN (mmol·L^{-1})	CK (ng·ml^{-1})	T(ng·ml^{-1})	E2(pg/ml)
Adjustment period	125.0±1.80	4.25±0.85	-	0.22±0.040	-
2017.8.20	124.4±2.20	7.71±0.60	131.16±28.20	0.165±0.046	-
2018.8.11	121.0±5.67	5.73±0.80	127.34±14.50	0.125±0.010	44.21±6.73
2019.8.12	125.2±6.40	4.61±1.42	128.73±23.35	0.134±0.070	43.56±5.35
2020.1.24	123.8±7.52	5.20±1.27	129.89±30.00	0.140±0.031	41.07±9.27

Table 5. Comparison of macro and trace elements of athletes in different periods.

	Mg/mmol·L^{-1}	Ca/mmol·L^{-1}	Fe/mmol·L^{-1}	Zn/umol·L^{-1}
Adjustment period	1.32±0.18	1.99±0.16	7.43±1.73	109.03±9.26
2017.8.20	0.95±0.20	1.58±0.06	7.21±0.29	96.75±13.77
2018.8.11	1.45±0.004	1.49±0.01	8.42±0.19	104.62±44.7
2019.8.12	1.34±0.09	1.67±0.19	8.78±0.78	103.65±8.98
2020.1.24	1.45±0.07	1.51±0.09	8.17±0.52	95.58±7.26

Table 6. Changes in athletes' basal heart rate and blood pressure in different periods.

	Heart rate/ time·min^{-1}	Systolic blood pressure/kPa	Diastolic blood pressure/kPa
Adjustment period	53.75±1.75	12.57±0.47	7.44±0.17
2017.8.20	57.75±1.75	13.63±0.57	8.48±0.46
2018.8.11	52.50±1.26	13.24±0.28	8.78±0.18
2019.8.12	58.71±4.11	14.60±0.85	8.86±0.63
2020.1.24	56.50±4.50	14.48±0.94	8.44±0.93

DISCUSSION

The body shape index of the excellent gymnasts in our country has certain advantages in the gymnastics special physical training. Regardless of the athletes' physical shape, shape index, and body composition, they all have the physical ability and shape quality to complete special gymnastics movements.[8] However, there are still differences in physical condition compared with excellent foreign gymnasts. The height of foreign elite gymnasts, especially European gymnasts, is above 170cm. He is tall, has long hands and legs, has a good temperament, and is flexible, stretchable, brisk, and strong in his movements. Chinese athletes slightly lack in this regard. For example, height affects the flexibility of movements in training, the length, and range of limbs, the difficulty of aerial movements, etc. It has a certain impact on sports training and competition results.

Athletes' blood urea and creatine kinase have a certain increase after heavy physical training. The blood urea increased from 4.25mmol·L^{-1} to 7.7mmol·L^{-1}. The value of creatine kinase is (127-130) ng·ml^{-1}. Blood urea and creatine kinase are very closely related to athletes' athletic ability. Studies have shown that blood urea is (4-7) mmol·L^{-1} in the morning after training.[9] Creatine kinase is generally in the range of (100-200) ng·ml^{-1} after loading. This is the performance of the body's ability to adapt to the load.

From the above research, it can be seen that Chinese elite athletes' level of physical function is low. This will affect the exercise intensity and amount of physical training and restrict the improvement of exercise level and exercise ability.[10] However, blood urea and serum creatine kinase, which reflect the body's metabolic level and functional capacity, increased after increased exercise or high-intensity physical training. Although the increase is not large, the athlete feels fatigued. This suggests that athletes may be fatigued, fail to return to the best functioning state they should have, and form a virtuous training and recovery cycle.

CONCLUSION

The physical shape of the first-line gymnastics players in China has a strong advantage, which lays the foundation for physical training. Chinese gymnasts' heart rate and blood pressure during quiet and exercise are in the range of elite athletes, and the tracking measurement is very stable. This shows that the athlete's heart has a good pumping function. Creatine kinase, blood urea, and urine protein increased after exercise, but the increase was small. Therefore, athletes have the space and potential to carry out large-volume physical training. However, hematological indicators such as hemoglobin, macro and trace elements, blood testosterone, and estradiol are all at low levels. Therefore, it is necessary to strengthen the timely supplement of nutrition to meet physical training needs with large amounts of exercise. Through the test and analysis of the physiological load of individual gymnastics and team members in training, it is found that the heart rate can reach a higher level. The training center rate can reach up to 190 times·min^{-1}.

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