

# EFFECTS OF WARM-UP EXERCISES WITH INTERVAL TRAINING ON FITNESS OF GYMNASTS



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EFEITOS DOS EXERCÍCIOS DE AQUECIMENTO COM TREINAMENTO INTERVALADO NA APTIDÃO FÍSICA DE GINASTAS

EFFECTOS DE LOS EJERCICIOS DE CALENTAMIENTO CON ENTRENAMIENTO DE INTERVALOS EN LA APTITUD FÍSICA DE GIMNASTAS

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## ABSTRACT

**Introduction:** Competitive gymnastics training is extremely debated in the Chinese scientific community. It is only when coaches choose proper physical training methods, they can fundamentally improve gymnasts' physical fitness. **Objective:** Analyze the effect of warm-up exercises on gymnasts' physical fitness. At the same time, this paper analyzes the factors that influence the indicators of gymnasts' physical fitness. **Methods:** This paper selects several gymnasts as research objects. The gymnasts perform physical training with interval training warm-up for two months. Data of gymnasts' physical constitution and the indicators related to their function are tracked and tested. Morphological indicators include height, circumference and body composition; functional indicators include multiple physiological and biochemical indicators (blood and urine analysis). **Results:** Gymnasts increased urea and creatine kinase concentrations after warm-up physical training. However, there was no statistical difference ( $P > 0.05$ ). The primary functional status of the athletes was stable. The results showed a normal resting heart rate and a reduction of blood pressure in the elite athletes. **Conclusion:** Gymnasts using interval training can maintain high intensity levels for prolonged periods. The indicators of physical fitness were above average. However, players' fitness to complete the movement set needs to be improved. **Level of evidence II; Therapeutic studies - investigation of treatment outcomes.**

**Keywords:** Gymnastics; Athletes; Physical Conditioning, Human; Warm-Up Exercise.

## RESUMO

**Introdução:** O treinamento de ginástica competitiva é extremamente debatido na comunidade científica chinesa. Somente quando os treinadores escolhem métodos adequados de treinamento físico, eles podem melhorar fundamentalmente a condição física dos ginastas. **Objetivo:** Analisar o efeito de exercícios para aquecimento sobre a aptidão física dos ginastas. Ao mesmo tempo, este trabalho analisa os fatores que influenciam os indicadores da aptidão física dos ginastas. **Métodos:** Este trabalho seleciona vários ginastas como objetos de pesquisa. Os ginastas realizam treinamento físico com aquecimento por treinamento intervalado durante dois meses. Dados de constituição física dos ginastas e os indicadores relacionados à sua função são rastreados e testados. Os indicadores morfológicos incluem altura, circunferência e composição corporal; os indicadores funcionais incluem múltiplos indicadores fisiológicos e bioquímicos (análise de sangue e urina). **Resultados:** Os ginastas aumentaram a concentração de ureia e creatinaquinase após o treinamento físico de aquecimento. Entretanto, não houve diferença estatística ( $P > 0,05$ ). O estado funcional primário dos atletas demonstrou-se estável. Os resultados mostraram um ritmo cardíaco em repouso normal e uma redução da pressão sanguínea nos atletas de elite. **Conclusão:** Ginastas que utilizam treinamento intervalado podem manter níveis de alta intensidade por períodos prolongados. Os indicadores de aptidão física foram acima da média. Entretanto, a aptidão física dos jogadores para completar o conjunto de movimentos precisa ser aprimorada. **Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.**

**Descritores:** Ginástica; Atletas; Condicionamento Físico Humano; Exercício de Aquecimento.

## RESUMEN

**Introducción:** El entrenamiento de la gimnasia de competición es muy debatido en la comunidad científica china. Sólo cuando los entrenadores eligen métodos de entrenamiento físico adecuados, pueden mejorar fundamentalmente la forma física de los gimnastas. **Objetivo:** Analizar el efecto de los ejercicios de calentamiento en la condición física de los gimnastas. Al mismo tiempo, este documento analiza los factores que influyen en los indicadores de la aptitud física de los gimnastas. **Métodos:** Este trabajo selecciona a varios gimnastas como objeto de investigación. Los atletas realizan un entrenamiento físico con calentamiento por medio de un entrenamiento por intervalos durante dos meses. Se hace un seguimiento de los datos, de la constitución física de los gimnastas y de los indicadores relacionados con su función. Los indicadores morfológicos incluyen la altura, la circunferencia y la composición corporal; los indicadores funcionales incluyen múltiples indicadores fisiológicos y bioquímicos (análisis de sangre y orina). **Resultados:** Los gimnastas aumentaron las concentraciones de urea y creatina quinasa después del entrenamiento físico de calentamiento. Sin embargo, no hubo diferencias estadísticas ( $P > 0,05$ ). El estado funcional primario de los atletas era



estable. Los resultados mostraron una frecuencia cardíaca en reposo normal y una reducción de la presión arterial en los atletas de élite. Conclusión: Los gimnastas que utilizan el entrenamiento por intervalos pueden mantener niveles de intensidad elevados durante períodos prolongados. Los indicadores de aptitud física estaban por encima de la media. Sin embargo, es necesario mejorar la aptitud de los jugadores para completar el conjunto de movimientos.

**Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.**

**Descriptor:** Gimnasia; Atletas; Acondicionamiento Físico Humano; Ejercicio de Calentamiento.

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## INTRODUCTION

Modern gymnastics requires athletes to have good physical shape and require athletes to have a good level of function. This article tracks and tests the physical form and function of gymnasts. This article tested the heart rate of some athletes completing a set of movements.<sup>1</sup> This is an attempt to explore the physical characteristics of gymnasts in China. The research conclusions of this paper lay a theoretical foundation for improving the physical fitness level of gymnasts in complete sets of movements.

## METHOD

### General information

This paper tracked and tested ten gymnasts' body shape and function-related indicators. We measured various physical performance indicators in athletes during adjustment and training sessions.<sup>2</sup> Among them, morphological indicators include length, girth, and body composition. Functional indicators include physiological and biochemical (blood, urine detection) indicators.

### Motion image arc trajectory contour extraction

In this paper, the interpolation operation of the radian trajectory positioning of the gymnastic arm movement is obtained by reconstructing the visual information of the image:

$$g = \beta_u \frac{\delta y}{\delta x} + A + \sigma \quad (1)$$

We solve to obtain the contour information points at  $(x, y, \sigma)$  of the sub-block region of the gymnastic arm movement arc image. In this paper, the interpolation fitting method is used to obtain the last feature information points of the arc trajectory sequence of gymnastic arm movements:

$$\begin{aligned} H_1 : U(t) &= g_i + u_i + e_i \\ H_0 : U(t) &= \frac{\delta y}{\delta x} + \sqrt{u_i} \end{aligned} \quad (2)$$

$\frac{\delta y}{\delta x}$  indicates that the positioning accuracy of the radian trajectory of the gymnastic arm movement is relatively high.  $u_i$  represents the information structure of gymnastic arm movements.  $g_i$  represents the edge information of the radian image of the gymnastic arm movement.  $e_i$  represents a non-Gaussian statistic.  $u_i$  represents the division scale of the gymnastic arm movement radian in the sub-block area.  $H_1$  represents the uniform quantization scale.<sup>3</sup> We use ambiguity detection and likelihood estimation to obtain the discriminant function for the arc detection of gymnastic arm movements:

$$\Lambda(U) = K_w + \eta \quad (3)$$

We use the similarity feature decomposition method to obtain the scale of the radian trajectory positioning of the gymnastic arm movements:

$$LRT(U) = \ln \Lambda(U) \leq \ln \eta \quad (4)$$

$\ln \eta$  represents the contour line of the radian trajectory distribution of the gymnastic arm action image.<sup>4</sup> In this paper, singular value decomposition is used to restore the arc trajectory of gymnastics arm movements. The expression is as follows:

$$\rho_{csc} = \theta * T_{lamm} + \sum_b k, t \quad (5)$$

$\theta * T_{lamm}$  indicates that corner information detection and ambiguity noise reduction analysis methods are used.<sup>5</sup> We get the trajectory contour extraction function on the radian plane of the gymnastic arm action:

$$L(a, b_m) = \sum_{i=1}^n u \sum \rho_{csci} + \lambda \quad (6)$$

$\lambda$  is the regularization parameter for the radian distribution of gymnastic arm movements.

## Mathematical Statistics

This paper uses SPSS13.0 statistical software to carry out mathematical statistics on the measured data. At the same time, we conduct correlation analysis on the statistical results.

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

## RESULTS

The physical fitness indicators of gymnasts meet the requirements of world elite athletes.<sup>6</sup> The body shape of gymnasts is well-proportioned from the study of the morphological index. The cardiovascular system functions well. It can be seen from Table 1 that the hemoglobin value of gymnasts fluctuates between 121 and 125 g/L. Hemoglobin values decrease after intensive physical training. Blood testosterone and estradiol levels of two hormones are at low levels of expected values. After high-volume physical training, gymnasts inevitably increase blood urea and creatine kinase. Athletes develop exercise-induced anemia after

**Table 1.** Comparison of hemoglobin, blood urea, creatine kinase, blood testosterone, and estradiol among athletes at different times.

	Adjustment period	2019.1.24
HB/g·L <sup>-1</sup>	125.0±1.80	123.8±8.52
BUN/mmol·L <sup>-1</sup>	4.25±0.85	5.20±1.28
CK/ng·mL <sup>-1</sup>	-	128.88±30.00
T/ng·mL <sup>-1</sup>	0.22±0.040	0.140±0.031
E2/pg·mL <sup>-1</sup>	-	41.08±8.28

high-volume training, the body is easily fatigued, and the metabolism of material and energy is poor.

Table 2 shows that the actual functional state of the athletes is stable. The results show that elite athletes have a good state of lowering heart rate and blood pressure at rest. Gymnasts' blood urea and serum creatine kinase increased after increased physical activity or high-intensity training.<sup>7</sup> The athlete's self-perceived fatigue suggests that the athlete may be fatigued or the functional level has not recovered to a good state. Athletes' heart rate and blood pressure increased after high-intensity training. It will take a week for it to return to its original level.

## DISCUSSION

Physical training uses various effective training methods and methods to transform the body shape of athletes. This improves the body's functional level and improves health and athletic performance.<sup>8</sup> Physical training is generally divided into general physical training and specific physical training. Gymnastics mainly involves the physical fitness of a complete set of gymnastics movements. It's not just about speed, strength, endurance, flexibility, and agility. It's about athletes completing a variety of proficiency and super-difficult equipment. This puts forward higher requirements for athletes' physical fitness. Therefore, all physical training needs to be combined with a set of movements. Scientific sports training is a process of training-fatigue-recovery-training-re-fatigue-re-recovery. If the training time exceeds 2 hours, it will be difficult for the players to concentrate. The quality of its movements is also difficult to guarantee. It is also prone to sports trauma. Therefore, coaches and players must update their concepts. The complete set of physical fitness training should be based on general physical fitness and exceptional physical fitness training. Gymnasts must follow the principles of physical training when performing physical training.<sup>9</sup> Athletes conduct physical training under systematic, comprehensive, combined, unique, and practical physical training.

In gymnastics competitions, the completion time of the complete set of actions for individual and group events is within 2min 30s. Its energy source is mainly glycolysis. Phosphate creatine assists energy supply. This article recommends using different interval training methods at different times. In this way, the training intensity in the training session is increased while the training quality is guaranteed.<sup>10</sup> The athlete's speed, strength, and endurance are developed through this method. General physical training can lay a good foundation for improving special physical training. Good exceptional physical fitness is the guarantee of technical and tactical implementation. The physical fitness training of gymnasts highlights the content of complete sets of physical fitness training based on ensuring general physical fitness training and special physical fitness training. We can arrange half sets of movement exercises or complete sets of movement exercises.

The complete set of physical training should be based on interval training. The trainer uses the athlete's heart rate to control the intensity of the exercise and take half a set of exercises. Each training time is 1min30s ~ 2min30s. Heart rate reached 180 beats/min. Athletes maintain

**Table 2.** Changes in basal heart rate and blood pressure in athletes during training.

	Heart rate/ time·min <sup>-1</sup>	Blood pressure	
		Systolic blood pressure (KPa)	Diastolic blood pressure (KPa)
Adjustment period	54.85±1.85	12.58±0.48	8.44±0.18
2019.1.24	56.50±4.50	14.48±0.94	8.44±0.94

an interval of 30 to 40 seconds at this heart rate. The athlete begins the next workout with a heart rate of 120 beats/min. This training is highly targeted.<sup>11</sup> This can effectively improve the fitness level of the gymnast's complete set of movements. At the same time, this also ensures a sufficient reserve of physical fitness for the complete set of movements during the competition.

Athletes can use very intense interval training methods interspersed in the complete set of physical training. Athletes train fast. We use heart rate as a valid measure of intensity. The training time is about 1 min. Heart rate can reach 190 beats/min. The heart rate drops to 130 beats/min during the interval to start the next workout. Gymnasts have different physical training plans during the preparation period and before the competition.<sup>12</sup> The training method can also use interval training. Preparing for a weekly training plan to increase the intensity of the training. We can arrange for two times of high intensity, three times of medium intensity, and one time of medium and low intensity. This ensures that the amount is small and the strength is significant. The purpose of training in the month before the competition is to consolidate the acquired competitive ability. This will keep you in the best competitive state. Coaches can arrange 4d weekly maximum exercise volume and maximum exercise intensity training. The athlete then began to perform 2d high-intensity and relatively small amounts of exercise. The last two weeks are sprint training. Athletes' exercise intensity and amount of exercise should be increased.

Increasing the training set's intensity is the functional reserve's material guarantee. "Functional reserves" require athletes to have a level of ability that is physically and technically far beyond what is required for the competition. Athletes use high-load, high-intensity training. Ultimately, we made the athlete's peak period coincide with the big game. In this way, the level of function "more than enough" can be easily played. The standard for judging the reserve is generally calculated according to the skill level required by the competition being 2 to 3 times higher. For example, in gymnastics training in Eastern European countries, athletes usually need to complete two or even three movements. The level of its skill reserve is high. Athletes can ensure high quality and easy performance during competition.<sup>13</sup> The test method of functional level is as follows: rest for 3 minutes after two consecutive sets of movements. Then we measure the cardiovascular system, neuromuscular system, and related biochemical parameters. The means to achieve functional reserve are overloading and actual combat simulation training. Overloading refers to high-volume, high-intensity exercise.

## CONCLUSION

A complete set of physical training can help athletes master complex and advanced technical movements. Athletes can maintain a good competitive state and mental state in training competitions. Athletes who strengthen physical training can complete more complex movements of different types of bodies and equipment within a specified time. In this way, athletes can obtain extra points for the proficiency and thrill of using a series of equipment techniques. The physical fitness of gymnasts has prominent unique characteristics. We recommend the interval training method in the complete set of physical training. Athletes use heart rate to control exercise intensity. Players maintain a high-intensity level for a particular time to increase the functional reserve of the complete set of movements.

The author declare no potential conflict of interest related to this article

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