

ATHLETE'S CARDIOVASCULAR FUNCTION TEST IN DIFFERENT SPORTS

TESTES DE FUNÇÃO CARDIOVASCULAR EM ATLETAS EM DIFERENTES ESPORTES

PRUEBAS DE FUNCIÓN CARDIOVASCULAR EN ATLETAS EN DIFERENTES DEPORTES



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Guohai Zhou¹ 
(Physical Education Professional)

1. Jingling Institute of Technology,
Nanjing, China.

Correspondence

Guohai Zhou
Nanjing 211169, China.
cxli2020@126.com

ABSTRACT

Introduction: There have been many reports on athletes' cardiovascular function, but there are very few methods used to evaluate the case. **Objective:** This article studies the relationship between sports fatigue and the cardiovascular response of athletes so that athletes can exercise and train more scientifically and safely. **Methods:** The paper selected some national athletes from 2017 to 2020 to carry out the VO₂max, step test, YoYo test, 12-minute running, and other tests related to the cardiovascular function. **Results:** Athletes can promote the improvement of their cardiovascular function when they perform aerobic exercise training. **Conclusion:** Public physical education and amateur physical training should focus on the development of aerobic endurance. This can improve athletes' cardiovascular function. **Level of evidence II; Therapeutic studies - investigation of treatment results.**

Keywords: Athletes; Cardiac rehabilitation; Sports.

RESUMO

Introdução: Existem muitos relatórios sobre a função cardiovascular de atletas, mas existem poucos métodos de avaliação. **Objetivo:** Este artigo estuda a relação entre fadiga por esporte e a resposta cardiovascular de atletas para que estes possam praticar exercícios e treinar de forma mais científica e segura. **Métodos:** O estudo selecionou alguns atletas de 2017 a 2020 para fazerem o VO₂max, o teste de fases, o teste YoYo, 12 minutos de corrida e outros testes relacionados à função cardiovascular. **Resultados:** Atletas podem promover a recuperação de sua função cardiovascular ao praticar treinos de exercícios aeróbicos. **Conclusão:** A educação física pública e treinos físicos amadores devem focar no desenvolvimento de resistência aeróbica, o que pode melhorar a função cardiovascular de atletas. **Nível de evidência II; Estudos terapêuticos - investigação de resultados de tratamento.**

Descritores: Atletas; Reabilitação cardíaca; Esportes.

RESUMEN

Introducción: Existen muchos informes sobre la función cardiovascular de atletas, pero existen pocos métodos de evaluación. **Objetivo:** Este artículo estudia la relación entre fatiga por deporte y la respuesta cardiovascular de atletas para que puedan practicar ejercicios y entrenar de forma más científica y segura. **Métodos:** El estudio seleccionó algunos atletas de 2017 a 2020 para que hicieran el VO₂max, la prueba de fases, el test YoYo, 12 minutos de carrera y otras pruebas relacionadas a la función cardiovascular. **Resultados:** Atletas pueden promover la recuperación de su función cardiovascular al practicar entrenamientos de ejercicios aeróbicos. **Conclusión:** La educación física pública y entrenamientos físicos amadores deben enfocarse en el desarrollo de resistencia aeróbica, que puede mejorar la función cardiovascular de atletas. **Nivel de evidencia II; Estudios terapéuticos - investigación de resultados de tratamiento.**

Descriptores: Atletas; Rehabilitación cardíaca; Deportes.



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INTRODUCTION

The function of the cardiovascular system is the most critical physiological basis of the human body's aerobic endurance level. The human body's ability to absorb and utilize oxygen in an extreme state is the maximum aerobic activity capacity, and the indicator reflecting this ability is the maximum oxygen uptake.¹ It is related to the function of the heart and lungs, the size and activity of muscles, the ability of blood to carry and transport oxygen, and the ability of tissues to absorb and utilize oxygen. However, although the direct test method of VO₂max has accurate results, the test technology is complicated, and the test equipment is expensive. This requires a lot of human resources and financial resources. Therefore, indirect methods are often used to test cardiopulmonary function. The more common ones are step test, 12-minute running, 20-meter reentry running, and so on.

Table tennis is the national game of China. In recent years, with the changes in the rules, the physical fitness requirements of athletes have become higher and higher. This requires athletes to have strong recovery capabilities. Therefore, the function of the cardiovascular system of table tennis players affects the athlete's performance to a certain extent. To facilitate the coaches to understand the athlete's situation in this respect in time, this study uses methods and loads related to table tennis training and competition.² This can test the heart rate of a table tennis player during a specific period of recovery after a quantitative load. We use the step test formula to calculate the recovery index to assess the functional status of table tennis players' cardiovascular system and further study the relationship between the test method and the traditional direct and indirect aerobic exercise test methods. This demonstrates the scientific and reliability of the method to perform scientific and technological research services better.

METHOD

Research object

We selected 80 athletes who participated in the national table tennis youth training camp from 2017 to 2020. Among them, 40 are female athletes, and 40 are male athletes. The details of the athletes are shown in Table 1.

Research methods

Maximum oxygen uptake

Use DHYSIO-DYNEmax-1 automatic gas analyzer for gas analysis. The article consists of 7 stages with different speeds and slopes to give quantitative exercises. Exercise for 3 minutes in each stage, and the end of the exercise will be determined by professionals.

Step test

We use student physical fitness monitoring equipment to carry out the load following the standard load plan.³ The experiment records the heart rate 30 seconds after each minute. Finally, record the score and heart rate displayed by the instrument.

12 minutes run

The subjects ran for 12 minutes to the best of their abilities in a standard 400-meter field. 8 people are tested each time.⁴ After hearing the termination signal, the subject stopped running and jogged or walked on the spot. The recorder records the entire distance.

YoYo test

We use standard YoYo test tapes. The subject strictly followed the prescribed time to complete a 20-meter round trip and rested for 5 seconds. Perform the next 20-meter turnback test.

Sports injury model

Assuming that the segment selection data is W_k^2 , A, the peak value of the data in the segment is selected. There are the following formulas:

$$V_{MAX} = \max_i \left\{ A \left(W_k^2 \mid N_k^{(i)}, X \right) \right\}_{i=1}^N = \max_i \left\{ A \left(W_k^2 \mid N_k^{(i)}, e^\theta \right) \right\}_{i=1}^N \quad (1)$$

A is the standard deviation of the selected tier data. $N_k^{(i)}$ is the discriminative trend degree of the k data under the data distribution of i . X is the pointing discriminant parameter. e^θ is the representative quantity finally selected in the θ data range. The trend analysis process of big data needs to be embodied in the form of set operations, and the relational expression between them is:

$$R(\theta) = S \frac{\sum_{m \times n} \prod_{i=1}^n p \{ \varpi \times 0.78(\alpha_1(\varpi) = A_2, \dots, X_M(\varpi) \in D) R \}}{\sum_{m \times n} \prod_{i=1}^n p \{ \varpi \times 0.78(\theta_1(\varpi) = A_1, \dots, X_M(\varpi) \in D) R \}} \quad (2)$$

Table 1. The basic situation of athletes.

Gender	Female	Male	
Training years	7.53 ± 2.63	8.32 ± 2.49	
Age (year old)	14.67 ± 2.98	15.73 ± 2.62	
Sport level	Master	12	11
	First level	20	19
	Level 2	8	10
Play type	Chopping	5	4
	Fast reverse glue arc	22	28
	other	13	8
Grip	Pen-hold shot	6	5
	Horizontal shot	34	35

$R(\theta)$ is the characteristic value of the sports injury big data in the θ data range. S is the characteristic data of sports injury degree data. ϖ is the trend of the data in the selected characteristic data. D is the directional data of sports injuries. α, ϖ is the conversion coefficient of sports injury data.⁵ Through the calculation and analysis of the above formula, the criterion in the big data is obtained.

In this paper, d_j ($j = 1, 2, 3, 4$) is used as the evaluation result of these 4 kinds of damage, respectively. We use x_j to represent the damage evaluation result d_j to evaluate the damage degree value. Suppose k is the number of sports injuries. The fuzzy set is E_j ($j = 1, 2, 3, 4$), $\Sigma E_j = k$. Then, the standard calculation method for the membership degree r_j of the muscle sports assessment grade d_j is:

$$r_j = \frac{E_j}{k} \quad (3)$$

After the above calculation, the quantified value of the fuzzy damage set D can be calculated:

$$D = \sum_{j=1}^4 (r_j \times x_j) \quad (4)$$

After the above process, the index quantification process of the fuzzy damage set is completed.

RESULTS

erobic exercise capacity of table tennis players

It can be seen from Table 2 that male and female table tennis players have a longer tolerance time during extreme sports, and the absolute and

Table 2. Gas metabolism.

	Extreme sports (female)		Extreme sports (male)	
	Average	Standard deviation	Average	Standard deviation
Freq (min)	52.78	8.33	52.6	5.19
Vt (ml)	1208.67	171.7	1671.2	231.73
Ve (min)	63.19	9.4	87.76	13.52
VO2 (min)	1970.11	189.48	3042.67	420.45
VO2KG (kg.min)	44.02	3.07	61.6	7.07
RER	1.19	0.09	1.21	0.04
O2 Pulse (ml)	10.09	0.82	13.61	1.95
VE VO2 (ml)	32.07	3.71	33.28	2.36
VO2 BSA (m ² .min)	1403.82	77.2	1921.58	254.32
VEBSA (m ² .min)	44.93	4.85	57.15	7.9
Time(s)	713.33	41.83	810	72.6
Time(E)(s)	740	25.98	830	75.78
	Gas reserve (female)		Gas reserve (male)	
	Average	Standard deviation	Average	Standard deviation
Freq (min)	26.78	6.2	24.93	4.64
Vt (ml)	628	259.3	1024.6	224
Ve (min)	48.63	9.48	70.14	12.35
VO2 (min)	1450.67	182.41	2315.33	366.22
VO2 KG (kg.min)	32.4	3.35	52.09	6.25
RER	0.32	0.11	0.34	0.1
O2 Pulse(ml)	5.49	0.93	7.8	1.79
VE VO2(ml)	3.87	4.08	5.15	2.59
VO2 BSA (m ² .min)	1032.84	92.75	1312.91	224.9
VEBSA (m ² .min)	34.5	5.29	45.67	7.38

relative values of maximum oxygen uptake have reached a good level.⁶ This shows that the athlete's cardiovascular system has been dramatically improved after a long period of systematic training. The main reason for its improvement may be the improvement of the central adaptation of the heart so that athletes can have higher excitability, can play a higher potential, and perform more outstanding work.

Heart rate change rule of multi-ball test

In the multi-ball test, the average maximum heart rate of female athletes reached 183 beats per minute, male athletes reached 175 beats per minute, and some athletes had heart rates of more than 210 beats per minute. This shows that the amount of exercise in this test reaches the load of extreme sports, and it can be used for cardiopulmonary function tests of table tennis players. In the actual test, the athlete's heart rate can increase rapidly with increased exercise load and recover quickly after the exercise.⁷ Such slope changes result from the regulation of cardiovascular function by the nervous and endocrine systems, and it is also a manifestation of exercise-induced cardiac function adaptation. This shows that table tennis is an aerobic exercise, and regular participation in table tennis can improve the body's cardiovascular function.

Test results of different test methods and related relationships

It can be seen from Table 3 that no matter what kind of cardiovascular system function test means, the test results show that the cardiopulmonary function of male athletes is better than that of female athletes.⁸ This reflects the gender characteristics of cardiovascular function.

It can be seen from Table 4 that the multi-ball test has a higher correlation with the 12-minute running, step test, and YoYo test ($P < 0.05$), indicating that the multi-ball test method can better reflect the cardiovascular function of table tennis players.

Multi-ball test results for athletes of different training levels

It can be seen from Table 5 that there is a significant difference in the results of the multi-ball test of the three groups of athletes with different athletic abilities between men and women ($P < 0.05$). This shows that the higher the level of exercise, the stronger the athlete's recovery ability. Although a table tennis match does not require much exercise, it does not require much physical exertion.

Table 3. Different test methods.

		Male	Female
12 minutes run	Average	3000.13	2886.32
	Standard deviation	102.64	168.91
Step test	Average	82.64	78.91
	Standard deviation	12.58	13.01
Multi-ball test	Average	7.15	6.22
	Standard deviation	0.9	0.29
YoYo test	Average	2080	1577.86
	Standard deviation	547.54	482.73

DISCUSSION

In recent years, the rules of table tennis have undergone significant changes, and higher requirements have been placed on athletes' physical fitness. First, increasing the ball's diameter increases the ball's resistance in the air and its radius of rotation. Therefore, if the athlete hits the ball with the same speed and power as the small ball, the

Table 4. Correlation comparison between multi-ball test and other test methods.

		Male	Female
12 minutes run	Correlation coefficient	0.561	0.521
	Significance	0.043	0.048
Step test	Correlation coefficient	0.632	0.621
	Significance	0.016	0.021
Multi-ball test	Correlation coefficient	0.453	0.465
	Significance	0.056	0.059
YoYo test	Correlation coefficient	0.641	0.628
	Significance	0.015	0.018

Table 5. Comparison of multi-ball test results of different training levels.

	Index	Female	Male
Master	Average	7.01	7.63
	Standard deviation	1.09	1.25
First level	Average	6.51	7.13
	Standard deviation	0.56	0.68
Level 2	Average	6.12	6.98
	Standard deviation	0.4	0.58
variance analysis		$P < 0.05$	$P < 0.05$

quality of the return ball will decrease. This increases the number of rounds per point.⁹ This requires that the athletes effectively improve the quality of their return to cause the opponent to make mistakes. Athletes also need to strengthen their footwork mobility and recovery ability to take the initiative in a stalemate. In this test, the high-intensity exercise for 2 minutes, 2 minutes of rest, and 3 repetitions is like that of a table tennis game. In addition, the method of this test is the daily combined skills of middle and advanced athletes, so it better reflects the professional characteristics. This is suitable for table tennis players to test cardiopulmonary function.

If athletes want to win the game, they must recover their physical strength more quickly to meet the new game with a better competitive state so whether the athletes can recover their physical strength in a short time.¹⁰ This is essential for table tennis, which involves multiple matches a day, intense matches but short intervals. Therefore, in selecting talents, attention should be paid to selecting athletes with strong recovery abilities. In addition, the training should be based on the rhythm of the game and increase the amount of exercise so that the athletes can improve their recovery ability through training to ensure that the athletes can fully perform in the final stage of several competitions simultaneously.

CONCLUSION

Table tennis is an aerobic exercise. Adolescents' table tennis training based on aerobic metabolism can promote their cardiopulmonary function. This lays a solid foundation for the health of the cardiovascular system in adults. During the multi-ball test, the rhythm of the athlete's heart rate change, the recovery index of the cardiovascular system, and other related testing methods are related. This shows that the multi-ball test method can better reflect the cardiovascular system function of table tennis players. The test can be used to evaluate the function of the cardiovascular system of table tennis players.

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