IMPROVEMENT OF PHYSICAL CONDITIONS IN TENNIS PLAYERS UNDER HIGH ALTITUDES

APRIMORAMENTO DAS CONDIÇÕES FÍSICAS EM TENISTAS SOB ALTITUDES ELEVADAS

MEJORA DE LAS CONDICIONES FÍSICAS DE TENISTAS EN ALTITUDES ELEVADAS

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ABSTRACT

Introduction: Due to the lower atmospheric density at high altitudes, the spherical surface of the table tennis ball offers less resistance, requiring higher performance from its players. The athletes' reaction time and movement speed can improve significantly. Objective: This paper studies the changes in the fitness level of Chinese table tennis players under training at high altitudes. These results can serve as a reference to formulate and implement the training strategy of the Chinese table tennis team. Methods: The performance of 12 outstanding table tennis players in the competition was explored. After arriving at the high altitude, the athletes practiced training for four weeks. The athletes' biochemical parameters and heart rates were evaluated before and after training. These data were statistically treated. Results: The heart rate of the athletes in the third week after the experiment was lower than before, with no significant difference (P>0.05). The hematocrit value of table tennis players in training showed a temporary elevation after one week, significantly different from that before the experiment (P<0.05). After two weeks of exercise at a high altitude, the hematocrit value of the athletes remained at a high level (P<0.05). Conclusion: Table tennis players can improve their physical conditions with training at high altitudes, including aerobic and anaerobic properties. High-intensity exercise at high altitudes is also beneficial for improving athletes' strength, speed, and reaction time quality. ***Level of evidence II; Therapeutic studies - investigating treatment outcomes.***

Keywords: Hypoxia, Altitude; Tennis; Athletes; Physical Fitness.

RESUMO

Introdução: Devido à menor densidade atmosférica em altitudes elevadas, a superfície esférica da bola de tênis de mesa oferece menor resistência, exigindo um maior desempenho de seus jogadores. O tempo de reação e a velocidade de movimento dos atletas podem melhorar significativamente. Objetivo: Este trabalho estuda as alterações no nível de aptidão física dos jogadores de tênis de mesa chineses sob treinamento em altitudes elevadas. Estes resultados podem servir como referência para formular e implementar a estratégia de treinamento da equipe chinesa de tênis de mesa. Métodos: Foi explorado o desempenho de 12 jogadores de tênis de mesa de destaque em competição. Após chegarem em altitude elevada, os esportistas praticaram um treinamento por quatro semanas. Os parâmetros bioquímicos e o ritmo cardíaco dos atletas foram avaliados antes e depois do treinamento. Esses dados foram tratados estatisticamente. Resultados: O ritmo cardíaco dos atletas na terceira semana após o experimento foi menor do que antes, sem diferença significativa (P>0,05). O valor de hematócrito dos jogadores de tênis de mesa em treinamento apresentou uma elevação temporária, após uma semana foi significativamente diferente daquele antes do experimento(P<0,05). Após duas semanas de exercícios em altitude elevada, o valor do hematócrito dos atletas permaneceu em um nível elevado (P<0,05). Conclusão: Os jogadores de tênis de mesa podem obter um aprimoramento de suas condições físicas com o treinamento em altitudes elevadas, incluindo as propriedades aeróbicas e anaeróbicas. O exercício de alta intensidade em altitudes elevadas também é benéfico para melhorar a força, a velocidade e a qualidade de tempo de reação nos atletas. ***Nível de evidência II; Estudos terapêuticos - investigando os resultados do tratamento.***

Descritores: *Hipóxia de Altitude; Tênis; Atletas; Aptidão física.*

RESUMEN

Introducción: Debido a la menor densidad atmosférica en las alturas, la superficie esférica de la pelota de tenis de mesa ofrece menos resistencia, lo que exige un mayor rendimiento a sus jugadores. El tiempo de reacción y la velocidad de movimiento de los atletas pueden mejorar significativamente. Objetivo: Este trabajo estudia los cambios en el nivel de aptitud física de los jugadores de tenis de mesa chinos bajo entrenamiento a gran altura. Estos resultados pueden servir de referencia para formular y aplicar la estrategia de entrenamiento del equipo chino de tenis de mesa. Métodos: Se exploró el rendimiento de 12 destacados jugadores de tenis de mesa en competición. Tras llegar a la altitud, los deportistas practicaron el entrenamiento durante cuatro semanas. Se evaluaron los parámetros bioquímicos y la frecuencia cardíaca de los atletas antes y después del entrenamiento.

Estos datos fueron tratados estadísticamente. Resultados: La frecuencia cardíaca de los atletas en la tercera semana después del experimento era más baja que antes, sin diferencias significativas (P>0,05). El valor del hematocrito de los jugadores de tenis de mesa en entrenamiento presentó una elevación temporal, después de una semana fue significativamente diferente al de antes del experimento (P<0,05). Tras dos semanas de ejercicios a gran altura, el valor del hematocrito de los atletas se mantuvo en un nivel elevado (P<0,05). Conclusión: Los jugadores de tenis de mesa pueden obtener una mejora de sus condiciones físicas con el entrenamiento en altura, incluyendo las propiedades aeróbicas y anaeróbicas. El ejercicio de alta intensidad a gran altura también es beneficioso para mejorar la fuerza, la velocidad y la calidad del tiempo de reacción en los atletas.
Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.

***Descriptores*:** *Hipoxia de Altitud; Tenis; Atletas; Aptitud Física.*

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INTRODUCTION

The height of the table tennis playing field significantly influences the speed and spin of the ball. Gravity and air pressure affect the ball's movement in the air. Because oxygen is scarce at high altitudes, the resistance of the ball in the air is small, so the ping pong ball moves much faster than on the flat ground. And table tennis has a solid ability to rotate. Players who play on flat ground will have the illusion of "one touch away" as soon as they reach the plateau.[1] Height changes have a lot to do with ball speed, spin, arc, etc. In addition, these changes will also have a particular effect on sports, technology, etc. This paper analyzes the physical fitness changes of Chinese table tennis players in the plateau environment. These results can serve as a reference for formulating and implementing the training strategy for Chinese table tennis team.

METHOD

Research objects

This paper uses 12 national table tennis players as the test subjects. Check the players' heartbeat, breathing, blood chemistry, endocrine, and other parameters one and six weeks before the summit.[2] General fitness and exceptional fitness were tested on Sunday. During the first week of the plateau, the exact measurements were taken on the athletes simultaneously in the fourth and second weeks.

Investigation method

The 12 players were trained in a unified way according to the training plan. Competitors will measure the corresponding physiological and biochemical indicators on Saturday morning, and the corresponding physical fitness indicators will be measured on Sunday.

Table tennis trajectory simulation by fluid mechanics method

Boltzmann's formula is:

$$\frac{\partial p}{\partial y}+\xi\frac{\partial p}{\partial x}+F\frac{\partial p}{\partial \xi}=\Omega \quad (1)$$

The crux of the Boltzmann problem is that the collision term on the right-hand side of the equation is nonlinear.[3] The BGK approximation is a simplification of the Boltzmann equation. Mohamad et al. generalized it to the following formula to replace the BGK approximation of the Boltzmann equation:

$$\Omega^{BGK}=\frac{p_i^{\lambda q}-p_i}{\tau(p_i^{\lambda q}+p_i)} \quad (2)$$

In the equation τ is the time of the relaxation characteristic (concerning sticking). $p_i^{\lambda q}$ is the local equilibrium distribution function.[4] The equilibrium distribution function is:

$$p_i^{\lambda q}(x,y)=\omega_i\rho\frac{\lambda_i\beta+(\lambda_i\beta)^2-\beta^2}{\xi_s^2}+O(\beta^3)+\omega_i\rho \quad (3)$$

ξ_S is the lattice speed of sound. β is the macro speed. ω_i is the weight factor. ρ is the macroscopic density of the liquid. $O(\beta^3)$ is infinitely few. In this paper, the Boltzmann equations are discretized in space, velocity, and time according to the BGK approximation.[5] In this way, the grid Boltzmann equation is obtained in this paper. In this paper, the space, velocity, and time of the Boltzmann equation are discretized by the BGK approximation method. Finally, this paper converts it into the grid Boltzmann equation, including the external force:

$$\frac{p_i(x+\lambda_i\delta y,y+\delta y)}{p_i(x,y)}-=\frac{p_i^{\lambda q}(x,y)-p_i(x,y)}{\tau\left[p_i^{\lambda q}(x,y)+p_i(x,y)\right]} \quad (4)$$

λ_i is a discrete spatial quantity. δy is the time discrete step. $F_i(x,y)$ is the external force term. A simplified sub-Boltzmann equation without any external force term is introduced. Below is a simple grid Boltzmann equation.

$$\frac{p_i(x+\lambda_i\delta y,y+\delta y)}{p_i(x,y)}=\frac{p_i^{\lambda q}(x,y)}{\tau\left[p_i(x,y)\right]} \quad (5)$$

Data processing

This paper uses SPSS11.0 to conduct experiments. P<0.01 is a highly significant level.

ETHICAL COMPLIANCE

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Hangzhou Vocational &Technical College following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

RESULTS

Changes in heart rate and respiratory spectrum of athletes during high altitude exercise

Athletes who went from the flat to the plateau in the first week had a significant increase in the mean weekly heart rate growth rate (P<0.01) compared to before going to the plateau.[6] During the four weeks of high altitude exercise, the movement speed was similar to that before the high altitude exercise. The heart rate of athletes in the three-week flat ground training at the lower plateau was lower than that in the flat training area before going up to the plateau, but there was no significant difference (P>0.01).

Dynamic changes in blood composition of athletes during high altitude training

During the plateau training, the white blood count of the table tennis players showed a decreasing trend year by year, but there was no significant difference compared with that before the plateau training (P>0.01). The total number of white blood cells in the high-altitude exercise group increased after going off the high-altitude. Still, there was no significant difference in decreasing or increasing compared with before training (P>0.01). During high altitude training, the total amount of red blood cells in athletes showed an upward trend, significantly different from that before high altitude (P<0.01). The hemoglobin content in the athletes' blood showed an upward trend during altitude training, significantly different from before altitude training (P<0.01). During the plateau training, the hematocrit of table tennis players showed an apparent upward trend, and the value of the hematocrit also increased significantly (P<0.01). (Table 1)

Dynamic changes of biochemical indexes of athletes during high altitude exercise

In the first week of training at the plateau, the urea nitrogen content of the excellent table tennis players in China was higher than that of the plain training group, and in the third week, it was lower than that of the plain group.[7] There was a big difference in the amount of urea nitrogen at three weeks compared to before going to the plateau (P<0.01). The content of creatine kinase in athletes with different physiques was significantly different (P<0.01). The activity of Sarco kinase in high altitude training was higher than that in basic training, but it was not significantly different from that in basic training (P>0.01). The activity of sarcokinase decreased significantly during altitude training. Athletes' serum climbing ketone levels tended to decrease during high-altitude exercise. It was statistically significant compared to basic training (P<0.01). In the second week, the intensity of exercise at high altitude was significantly decreased compared with that before training, and there was a significant statistical significance (P<0.01). (Table 2)

Dynamic change law of athletes' overall physical fitness during high altitude training

60 M speed in plateau training is better than flat ground practice before going to plateau. Athletes performed better on average in the flat test three weeks after going down the plateau than before going up the plateau.[8] The data were statistically significant (P<0.01). There was a greater difference in the speed of 100 M compared to 60 M when straddling training on the plains (P < 0.01). When performing horizontal stretching of the upper body, the level of the athletes in the altitude training week was lower than that of the flat ground level (P<0.01).

DISCUSSION

If the table tennis ball is in motion with a rotating action, its rotation angle will become more prominent. The movements an athlete can do also get bigger.[9] This leads to the training effect of athletes on the plateau being far more effective than that on the plain. In this case, the athlete will significantly improve by returning to the flat when the limit is reached. And that's what we want to achieve.

When practicing table tennis on the plateau, because the air is relatively sparse, the movement speed of the table tennis ball is much faster than that on the flat ground. This has a significant effect on training table tennis.[10] Because of the high humidity in the plateau, the rebounding ability of table tennis will also be weakened. The ping pong ball becomes lighter and faster when it hits the ground.

Table 1. Dynamics of blood composition index of outstanding table tennis players during high altitude training.

Time	White blood cells (10^9/L)	Red blood cells (10^{12}/L)	Hemoglobin (g/L)	Hematocrit (%)
One week before altitude training	6.06±2.2	3.81±0.31	116.97±5.69	34.45±1.68
Altitude training week 1	4.88±0.17	4.06±0.22	125.99±8.65	37.16±2.26
Altitude training week 2	4.92±0.19	4.11±0.23	135.26±5.28	36.71±1.14
3rd week after the plateau	5.71±1.24	4.04±0.19	131.46±4.93	35.87±1.39

Table 2. Changes in blood biochemistry and hormone levels of outstanding table tennis players in training areas at flat and high altitudes.

Index	Urea nitrogen mmol/L	Creatine kinase μ/L	Testosterone ng/L
One week before altitude training	4.85±0.54	178.84±114.99	30.95±11.64
Altitude training week 1	5.2±1.11	265.89±194.01	28.14±12.68
Altitude training week 4	4.38±1.13	237.74±137.86	23.04±12.09
3rd week after the plateau	4.32±0.3	147.73±93.47	23.75±11.02

This makes it very difficult for the players in their daily practice and games. This also dramatically reduces the time required for their operation. For athletes, their physical fitness and physical fitness have greatly improved. They must be resilient enough and need long, high-intensity practice to better adapt to the terrain when they return to the field. Their explosiveness, agility, nerves, and nerves are much more muscular on the plateau than on the flat ground.

The low-concentration atmosphere of the plateau will accelerate the movement of the sphere. This affects the player's stability in two ways. One is to reduce the preparation of the swing and the general oscillation of the swing.[11] Getting used to this situation requires reducing the swaying of the arms and torso so that you can prepare early. This ensures a good landing spot right in front of you. The second is that when you hit the ball with the same amount of effort, the speed of the plateau ball is faster than that of the flat earth. That is to say, a force can hit a sphere under the opponent's feet on the flat ground, but it will be bounced off on the plateau.[12] To ensure a hit, you must reduce the force of the shot to shorten the shot's range. There is no guarantee that the initial length of the muscle at the limited rocker amplitude will reduce the strength of the muscle. This is the so-called "small motion fixation" theory. On the plateau, the arm swing of the general athlete is relatively low, and the strength is relatively weak. At this moment, the quality of the sphere is also relatively general. The ball is not as neat and stretched as when training on flat ground. In the same situation, the hitting force should be reduced as much as possible to avoid the ball going out of bounds. To reduce the frequency of the swing, you need to limit the contraction of the muscles. This has also become a bottleneck for athletes who want to improve their strength.

CONCLUSION

Table tennis players' speed will significantly improve after high-altitude physical exercise. The difference between the two groups was statistically significant. The upper body strength of table tennis players did not change much. The athlete's explosiveness, leg strength, and speed greatly improved.

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