FITNESS TRAINING OF ATHLETES IN FREESTYLE SKIING

TREINAMENTO DE APTIDÃO FÍSICA DE ATLETAS EM ESQUI DE ESTILO LIVRE

ENTRENAMIENTO DE APTITUD FÍSICA DE ATLETAS EN ESQUÍ DE ESTILO LIBRE

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ABSTRACT

Introduction: Physical training is essential to physical fitness in freestyle skiers. The domain of stability in the technical movements is a determinant of the competition, always constantly improving. Objective: Develop a physical training program adapted to freestyle skiing. Methods: Twelve freestyle skiers were selected as volunteers for the experiment. This paper compares athletes' physical qualities and individual abilities before and after physical training. Through recent research, the athletes' physical condition was comprehensively evaluated to test the effectiveness of their physical training. Results: Freestyle skiers showed good anaerobic fitness. A relationship was found between the maximum number of thrusts, the degree of spin in the air, the maximum power duration, and the power decay rate (P<0.05). In the body balance test, the lower limbs showed deficiencies in anteroposterior mobility, while bipodal balance showed no significantly statistical differences (P>0.05). Conclusion: This paper systematically studies body composition, the center of gravity strength, anaerobic capacity, and balance in freestyle skiers. The results provide a good assessment of the effect of fitness training on freestyle ski athletes. These results have particular guiding significance for formulating and implementing training programs focused on the sport. ***Level of evidence II; Therapeutic studies - investigation of treatment outcomes.***

Keywords: Skiing; Body Composition; Resistance Training; Anaerobiosis.

RESUMO

Introdução: O treinamento físico é parte essencial da aptidão física em esquiadores de estilo livre. O domínio da estabilidade nos movimentos técnicos é determinante sobre as competições, estando sempre em constante aprimoramento. Objetivo: Elaborar um programa de treinamento físico adaptado ao esporte do esqui de estilo livre. Métodos: Selecionou-se 12 esquiadores de estilo livre como voluntários ao experimento. Este artigo compara as qualidades físicas e habilidades individuais dos atletas antes e depois do treinamento físico. Através de pesquisas recentes, avaliou-se de forma abrangente a condição física dos atletas para testar a eficácia de seu treinamento físico. Resultados: Os esquiadores de estilo livre apresentaram uma boa praticabilidade anaeróbica. Foi encontrada uma relação particular entre o número máximo de propulsões e o grau de giro no ar, a duração máxima da potência e a taxa de decaimento da potência (P<0,05). No teste de equilíbrio corporal, os membros inferiores apresentaram deficiências de mobilidade anteroposterior, enquanto o equilíbrio bipodal não apresentou diferenças significativamente estatísticas (P>0,05). Conclusão: Este artigo fornece um estudo sistemático da composição corporal, força do centro gravitacional, capacidade anaeróbica e equilíbrio em esquiadores de estilo livre. Os resultados proporcionam uma boa avaliação do efeito de treinamento de aptidão física nos atletas de esqui de estilo livre. Estes resultados têm um significado orientador particular para a formulação e implementação de programas de treinamento focados na modalidade. ***Nível de evidência II; Estudos terapêuticos - investigação dos resultados do tratamento.***

Descritores: *Esqui; Composição Corporal; Treinamento de Força; Anaerobiose.*

RESUMEN

Introducción: El entrenamiento físico es una parte esencial de la aptitud física en los esquiadores de estilo libre. El dominio de la estabilidad en los movimientos técnicos es determinante sobre las competiciones, estando siempre en constante mejora. Objetivo: Desarrollar un programa de entrenamiento físico adaptado al deporte del esquí de estilo libre. Métodos: Se seleccionaron doce esquiadores de estilo libre como voluntarios para el experimento. Este artículo compara las cualidades físicas y las capacidades individuales de los atletas antes y después del entrenamiento físico. Mediante una investigación reciente, se evaluó exhaustivamente la condición física de los atletas para comprobar la eficacia de su entrenamiento físico. Resultados: Los esquiadores de estilo libre mostraron una buena aptitud anaeróbica. Se encontró una relación particular entre el número máximo de empujes y el grado de giro en el aire, la duración de la potencia máxima y la tasa de disminución de la potencia (P<0,05). En la prueba de equilibrio corporal, los miembros inferiores mostraron deficiencias en la movilidad anteroposterior, mientras que el equilibrio bipodal no mostró diferencias estadísticas significativas (P>0,05). Conclusión: Este artículo proporciona un estudio sistemático de la composición corporal, la fuerza gravitatoria central, la capacidad anaeróbica y el equilibrio en esquiadores de estilo libre. Los resultados

proporcionan una buena evaluación del efecto del entrenamiento físico en los atletas de esquí de estilo libre. Estos resultados tienen una especial importancia orientativa para la formulación y aplicación de programas de entrenamiento centrados en este deporte. ***Nivel de evidencia II; Estudios terapéuticos - investigación de los resultados del tratamiento.***

Descriptores: *Esquí; Composición Corporal; Entrenamiento de Fuerza; Anaerobiosis.*

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INTRODUCTION

Strength is an essential part of the physical fitness of Chinese freestyle skiers. The difficulty and stability of technical movements are the keys to determining an athlete's winning. The stability of technology at any time is based on solid strength. Sports ability is integrated with comprehensive abilities such as speed, flexibility, and coordination, and to a certain extent, it realizes precise control of various body parts. This can achieve the purpose of improving the technical level and stability of athletes.[1] Only when the movement pattern and muscle contraction rate meet the specific technical requirements can the athlete's muscles be effectively exercised. Only when the muscle groups and muscle groups are in harmony will the muscle strength of the body's various joints be unified to create a "force sequence." Only in this way can the athletes' exceptional strength quality be effectively improved.

METHOD

Research objects

This paper investigates 12 freestyle skiers as the research object. The basic information of the participating athletes is shown in Table 1 below.

Investigation method

Body Composition Test

The test contents mainly include intracellular and extracellular fluid, protein weight, bone weight, muscle fat diagnosis, fluid body diagnosis, comprehensive evaluation, etc. This paper focuses on studying fluid distribution at the site of humoral examination.

Core strength test

The waist and hip muscles were measured after the athletes were fully warmed up. The test speed is 60°/sec. Five times for each action, take the maximum value as the peak power. Results of muscle strength measurements were dominated by left/right and contraction patterns.[2] The detection of muscle strength is divided into left/right concentric contraction and left/right eccentric contraction. The interval between the two groups is 2 minutes.

Anaerobic metabolism ability test

This article uses the Monark839-powered bicycle produced in Sweden as the test medium.[3] Athletes perform a maximal continuous motion test for 30 seconds. The test indicators are maximum power (Pmax), average power (AP), maximum power arrival time (S), and maximum torque (Cmax).

Dynamic equalization test

This paper measured skiers using a balance performance tester from Beedeks, UK. Adjust the body's center of gravity during the test to position the pointer as precisely as possible on the horizontal axis.[4] This paper mainly tested the comprehensive shaking index, the forward shaking index, the inside and outside shaking index, and so on.

Table 1. Profile of participating athletes.

Group	Age	Height/cm	Weight/kg	Training years
Men's	27.16±3.37	195.05±3.68	93.26±4.63	10.84±3.68
Women's	27.68±2.63	183.05±2.95	72.74±2	10±2.74

The rotational inertia of the athlete's mid-air prancing action

The moment of inertia of any many-body system is a tensor related to its weight distribution. When the human body flips in the air, the body's angular momentum is constant, producing a specific angular rate and displacement in the directions of the three axes around the body.[5] The athlete adjusts the angle of the body by bending the body and the movement of the arms to achieve technical movements. In Equation (1), the matrix of the overall inertia tensor of the body is expressed as:

$$A = \begin{bmatrix} A_{xx} & -A_{xy} & -A_{xz} \\ -A_{xy} & A_{yy} & -A_{yz} \\ -A_{xz} & -A_{yz} & -A_{zz} \end{bmatrix} \quad (1)$$

A_{xx}, A_{yy}, A_{zz} is the moment of inertia between the rigid chain body and each axis of x, y ,z, and A_{xy}, A_{xz}, A_{xz} is the inertia product of the chain rigidity. If A_{xx} and A_{xy} are respectively defined as

$$A_{xx} = \int (y^2 + z^2) ds \quad (2)$$

$$A_{xy} = \int xy ds \quad (3)$$

The matrix A is a fundamental symmetry. It is given that all off-diagonal elements are 0. At this time, the structure of the inertia matrix is as follows

$$A^{(0)} = \begin{bmatrix} A_1 & 0 & 0 \\ 0 & A_2 & 0 \\ 0 & 0 & A_3 \end{bmatrix} \quad (4)$$

A_1, A_2 and A_3 on the opposite corners are the principal moments of inertia of the rigid system.[6] In this paper, the calculation program written in MATLAB 6.5 is used to convert the inertia tensor of the athlete's action in turning in the air into the central inertia moment.

Data Analysis

All data were statistically analyzed using Excel.

Ethical Compliance

Research experiments conducted in this article with animals or humans were approved by the Ethical Committee and responsible authorities of Hebei Sport University, Hebei University of Economics and Business and Harbin Sport University following all guidelines, regulations, legal, and ethical standards as required for humans or animals.

RESULTS

Analysis of body composition test results

This article judges the balance of body development after exercise based on the data of fluid body examination. Table 2 shows that male freestyle skiers have more right-side than the left-side distribution of body fluids. In women, there is more fluid on the left side of the body than on the right side.[7] Men's body strength is more muscular on the right side than the left side in regular sports, while women's strength is equal. Males and females distribute more fluid to the lower extremities than the upper extremities. The same happened with fluid distribution in the torso.

Core Strength Index Results

Table 3 shows that the measurement of hip flexor strength in male freestyle skiers' left and right legs was essentially the same. There is a clear difference in the strength of the right-hand side. There is not much difference in hip flexion and extension between the left and right legs. Freestyle skiers have more balanced hip flexor and extensor development.[8] The flexor strength of the back muscles is significantly lower than that of the extensor muscles. This offset did not significantly change the flexion and extension rates of the lower back muscles. The status of the women's team is similar to that of the male freestyle skiers. The results showed that the athlete's right femoral extensor muscle strength and low back flexor peak power were lower than average.

Effect of anaerobic test

Table 4 is the experimental data of freestyle skiers in terms of anaerobicity. The maximum output of the male freestyle skier was 840.32 W, and the highest was 10.53 W. Athletes have greater strength when maximal anaerobic capacity is increased.[9] This means that the body's muscles can generate a high-power output for a short time.

Maximum RPM is the maximum speed that a bike can reach. It reflects the maximum frequency band relaxation and contraction strength of the lower limb muscle movement of the human body.[10] This value is generally related to the type of nerve fiber.

Analysis of the results of the balance test

Balance is the most fundamental strength of a person to maintain a posture. Balance is inextricably linked with essential human qualities such as strength, endurance, coordination, and agility. It is premised on the coordination of muscles. The level of balance can be judged from three perspectives: sitting posture, standing posture, and movement. Its primary contents include static stability, motion coordination, and static motion anti-disturbance. Table 5 shows the results of the balance test of the free skaters.[11] This shows that the balance between male freestyle skiers' left and right legs is not much different. The left leg is less potent than the right leg. The opposite is true for female freestyle skiers. Both males and females have low stability on both front and rear levels. There are differences in cognition and compensatory abilities among individuals, which are important reasons for the differences in individual balance abilities.

Table 2. List of Athlete's Humidological Indicators.

Group	Left upper extremity	Right upper extremity	Trunk	Left lower extremity	Right lower extremity
Men's	3.33±0.11	3.35±0.09	26.87±0.56	8.61±0.59	8.77±0.66
Women's	2.26±0.11	2.25±0.14	18.56±0.74	6.33±0.18	6.28±0.2

Table 3. Summary of Core Strength Test Results for Freestyle Skiers.

Part	Side by side	Men's	Women's
Hip flexor peak power/W	Left	170.12±27.45	126.87±22.14
	Right	169.31±17.62	128.14±32.02
Hip extensor peak power/W	Left	310.36±66.71	251.14±26.15
	Right	268.49±45.64	226.61±49.14
Hip flexor/ extensor ratio/%	Left	67.41±18.12	72.11±25.75
	Right	68.91±11.46	75.08±22.07
Back peak power/W	Qu	234.43±51.89	178.47±42.42
	Stretch	312.71±80.8	238.42±27.15
lumbar dorsiflexor extensor ratio/%		95.68±33.53	88.32±7.88

Table 4. List of Anaerobic Work Measurement Results for Freestyle Skiers.

Group	Men's	Women's
Maximum power/W	840.32±79.05	632±74.32
Relative maximum power/(W/kg)	10.53±1.58	8.95±0.84
Average power/W	646.32±28.95	505.68±55.26
Maximum revolutions/RPM	151.89±13.58	120.84±8.42
Time to reach maximum power/s	6.63±1.26	5.89±0.95

Table 5. List of balance test scores for freestyle skiers.

Group	Men's	Women's
Gross left foot	2.11±0.59	1.82±0.59
Left foot flexion	1.46±0.48	1±0.44
The left foot inside and outside	1.31±0.43	1.42±0.67
Total right foot	2.03±0.66	2.34±0.62
Right foot flexion	1.48±0.39	1.4±0.53
The right foot inside and outside	1.22±0.62	1.63±1.11

DISCUSSION

After physical training, the comprehensive abilities of freestyle skiers have been improved. The athlete's speed, endurance, balance, coordination, and other abilities have significantly improved. Core strength is key to supporting a freestyle skier's poles and kicks. Core strength can also enhance the stability of the movement in an unstable state, increasing the output of continuous support and kicking. The enhanced agility and coordination of freestyle skiers play a considerable role in effectively transforming winter skiing techniques and ground training.[12] At the same time, the training methods and means of agility and coordination are relatively new and exciting. Physical training methods can enrich the training effect and mobilize the initiative of freestyle skiers in training. Coaches and researchers must be innovative and exciting in their training methods. Coaches need to diversify training methods to cultivate students' interest in training. This allows for seamless integration and conversion between ground and snow training.

Strength training is essential to physical fitness among high-level freestyle skiers in China. The connection between sports and special physical training is divided into primary and professional. In this paper, they are divided into two categories: static and dynamic, according to the characteristics of their motor functions. The primary manifestation of skiing technology is to develop speed, body stability, and balance control when rapidly exerting force in an unstable state. This training style is closely linked to the motor characteristics of a particular technique. In this way, the contraction pattern of the movement, the impulse frequency, and the movement pattern of the particular technique are coordinated. The training method can promote the transformation of the essential ability in a particular direction so that the physical fitness of the freestyle skier can be better trained.

CONCLUSION

Physical fitness and core strength tests reflect imbalances and asymmetries in physical strength. Regarding body balance, male freestyle skiers have weaker left and right legs in both front and rear directions, while female freestyle skiers have weaker lateral balance. The balance ability of freestyle skiers is related mainly to unique ability and sports performance.

All authors declare no potential conflict of interest related to this article

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