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Morphological and Strength Parameters of Chinese Young Freestyle Skiing Aerials Athletes

Parámetros Morfológicos y de Fuerza de Jóvenes Atletas Chinos de Esquí Acrobático Aéreo

Yuening Li[1]; Ying Yao[1]; Yongjie Gao[1]; ,Tianyi Han[2]; Quangang Wu[2] & Ping Gao[1]

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SUMMARY: This study analyzed the body shape, strength parameters, and characteristics of young Chinese freestyle skiing aerials athletes and proposed corresponding training strategies. Twenty athletes participating in the China freestyle skiing Aerials U-series competition were selected as the subjects. The test indexes included height, weight, body fat percentage, lower limb length percentage, Achilles tendon length, waist circumference, Quetelet index, bench press and squat maximum strength, power clean, depth jump, knee joint isometric strength, and hip joint muscle strength. Awarded athletes were taller and heavier, had a lower body fat percentage, a more significant percentage of lower limb length, and a greater Quetelet index than non-awarded athletes. The results of bench press, squat absolute strength, power clean, and depth jump are better, which indicates that the base strength of upper and lower limbs, explosive power of trunk and lower limbs, and synergy among them are the key strength qualities that affect the competitive performance of young aerials athletes. Chinese youth aerials athletes generally have the primary joint flexor, extensor muscle group, left and right muscle group power imbalance problem, which should strengthen the athlete's trunk fast flexor, extensor muscle group, knee joint fast concentric and eccentric force, and hamstring muscle strength, and optimize the balance of left and right side strength.

KEY WORDS: Freestyle Skiing Aerials; Morphology; Strength; Anthropometric; Young athletes.

INTRODUCTION

Freestyle skiing aerials originated in the United States in the 1960s and evolved from alpine skiing as a highly challenging winter sport. The International Ski and Snowboard Federation (FIS) officially recognized it in 1979, and it was introduced as an event at the 1994 Lillehammer Winter Olympics. China began to develop the sport in the late 1980s and won its first Olympic title in men's freestyle skiing aerials at the Turin Winter Games in 2006. In the 2022 Beijing Winter Olympics, the Chinese team won two gold and one silver medal in the freestyle skiing aerials. It achieved the first Olympic breakthrough in women's aerials, which fully demonstrated the competitive strength of this dominant snow sport in China (Yao & Niu, 2014; Xu *et al*., 2022).

The freestyle skiing aerials competition venue includes a sliding aid, transition area, jumping platform, landing slope, and stopping area. The technical movements include two series: straight body and somersault. Among them, the straight body series of movements is relatively simple and has a low score, mainly including straight lower body twisting and swinging, straight back bending of the calf, and other movements. Somersaults are more complex and thrilling, with higher scores, mainly including front somersaults, side somersaults and back somersaults, etc. At the same time, with different degrees of rotation to increase the difficulty. The competition adopts the referee scoring system. The athlete's score for each jump is calculated by the sum of the three parts of the air score, the aerial maneuver score, and the landing score multiplied by the difficulty coefficient. Generally, the more complex and better the quality of the action, the higher the likelihood of victory. (Yeadon, 2013; Jiang *et al*., 2023).

The freestyle skiing aerials is a movement structure comprised of four technical links: approach, takeoff, aerial

[1] Research Center for Innovative Development in Sports and Health, College of Sport Training, Wuhan Sports University, Wuhan, China.
[2] Fitness Management College, Hubei Sports Vocational College, Wuhan, China.
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maneuver, and landing. The athletes of the triple platform glide at about 55 ~ 68km/ h and then take off through the jump platform with an Angle of 70° at a height of about 4m. After taking off, the athletes must perform somersaults and turns in the air. The maximum height of the air movement is about 16m. Finally, the athletes must stand on the landing slope of 38° and slide out smoothly after completing the high-speed somersaults and turns. The landing technique determines the final result of the success or failure of the entire technical movement (Lou *et al*., 2016). Stability, difficulty, and accuracy are the main competitive characteristics of aerials. In training and competition, athletes must complete complex flips and rotations, which place high demands on their body control ability.

Hip, knee, ankle, and trunk muscle strength are critical physical qualities for aerials athletes, and they are also important guarantees for athletes to complete high-quality movements and ultimately successful landings (Lou *et al*., 2022). In the approach phase, the athlete must maintain a stable posture to achieve a suitable takeoff speed. In the takeoff phase, the athlete locks the torso, hip joint, and knee joint so that the body is nearly rigid to obtain a higher height and distance. In the air phase, the athlete should keep the torso stable while exerting enough force to maintain the technical movement characteristics. In the landing phase, athletes need strong centrifugal force in the lower limbs and balance and stability to land successfully and avoid injury. (Ma *et al*., 2012; Lou *et al*., 2021; Wei *et al*., 2022, 2023)

Studies have been conducted to analyze the physical characteristics of elite aerials athletes by testing body morphology and athletic quality parameters. For example, Niu *et al*. (2018), selected Achilles tendon length, waist circumference/height * 100, pelvis width, and Quetelet index as Chinese elite aerials athletes' key body morphology indexes. Among them, the Achilles tendon length of male and female athletes is 21.97±1.04cm and 20.63±0.75cm, respectively. Waist circumference/height 100 was 43.23±1.66 and 42.08±2.43, respectively; the pelvic width was 29.58±0.73cm and 25.72±0.76cm, respectively; Quetelet's indices were 393.55±17.63 and 341.20±18.25, respectively. Yao & Niu (2023), constructed an evaluation index system for the athletic quality of excellent freestyle skiing aerials, covering four aspects: strength, speed, endurance, and agility. The strength test includes deep squats, pull-ups, and power clean. Niu *et al*. (2018), tested the power clean performance of the Chinese aerials team athletes, and the men and women athletes were 91±8.94kg and 60±7.07kg, respectively. Ma *et al*. (2012) showed that the optimal hip and knee angles for elite freestyle skiing aerials were 120.44 ~ 144.49° and 119.61 ~ 148.28°, respectively.

The competitive level of Chinese freestyle skiing aerials is in a leading position globally. Existing studies have tested and analyzed the body morphology and strength parameters of Chinese elite freestyle skiing aerials athletes from the perspectives of anthropometry and dynamics, providing an important basis for the physical training practice of this event. Young athletes are the reserve force of competitive sports talents. However, research on the relevant parameters of young freestyle skiing aerials athletes is relatively rare. Therefore, this study uses the test method and mathematical statistics to analyze the body morphology and strength parameters of China's outstanding young aerials athletes and puts forward corresponding training strategies, which can provide relevant training parameters for coaches, athletes, researchers, and related enthusiasts of this sport, and provide theoretical reference for talent identification and physical training of this sport.

MATERIAL AND METHOD

Participants and study design. Twenty adolescent athletes (age: 15.9 ± 1.86 years; males: 10, females: 10) who participated in the Chinese Freestyle Skiing Aerial Skills U-Series competitions were the subjects of the study, including 6 (males: 3, females: 3) medalists and 14 non-medalists. All subjects signed an informed consent form, and the study protocol was reviewed and approved by the Scientific Research Ethics Committee of Wuhan Sports University.

Data collection and instruments. A tape measure, scale, and body composition analyzer (Korean X-SCAN PLUS II) were used to test anthropometric parameters, including height, weight, body fat percentage, lower limb length percentage, Achilles tendon length, waist circumference, and Quetelet index. Bench press, barbell stand, and box jump were used to test the maximum strength of bench press, squat, power clean, and depth jump. All tests were fully warmed up. The maximum strength of bench press, squat, and power clean tests were divided into three incremental loads. The maximum weight that could be completed was taken as the final test result, and the maximum value was taken for three times of depth jump tests. The isokinetic muscle force evaluation system (Germany IsoMed, 2000) is used for 60°/s and 180°/s knee isokinetic muscle force test; the test indicators include both side flexion, extension peak torque, relative peak torque, maximum power, and relative power. Force frame hip strength and NordBord hamstring muscle test systems were used to test hip and hamstring muscle strength, respectively.

Statistical analyses. SPSS(version 25.0, IBM Corp Armonk, NY, USA.) was used for descriptive statistics of body morphology and strength and diathesis parameters expressed as mean ± standard deviation (SD). An Independent sample t-test was used to compare the body morphology and mechanical parameters of the medalists and non-medalists young aerials athletes. p≤0.05 indicates a significant difference, and p≤0.01 indicates a very significant difference.

RESULTS

Table I shows that, in terms of body morphology parameters, the medalists are older than the non-medalists (male: 16.7±0.6 *vs*. 15.4±2.2 years, p=0.38; female: 16.3±1.5 *vs*. 15.9±2.1 years old, p=0.74) and taller (male: 170.7±4.9 *vs*. 169±9.2 cm, p=0.78; female: 167.0±6.6 *vs*. 161.9±5.7 cm, p=0.24), significant weight (male: 59.3±2.9 *vs*. 56.5±9.2 kg, p=0.63; female: 58.7±2.2 *vs*. 52.5±7.5 kg, p=0.07), low body fat percentage (male: 8.7±0.1 *vs*. 11.4±1.9 %, p=0.03; female: 18.4±4.4 *vs*. 21.4±4.7 %, p=0.33), lower limb length accounted for a more significant proportion (male: 53.4±1.1 *vs*. 51.8±1.1%, p=0.07; female: 53.4±0.9 *vs*. 51.4±1.5 %, p=0.66), the length of calcaneal tendon was slightly shorter in male (20.2±0.7 *vs*. 20.4±2.0 cm, p=0.87), and slightly longer in female (17.4±2.5 *vs*. 17.2±2.7 cm, p=0.93). Waist length was slightly shorter in males (69.4±2.6 *vs*. 70.5±1.8 cm, p=0.42), slightly longer in females (77.5±2.4 *vs*. 72.3±5.4 cm, p=0.42), and the Quetelet index was more extensive (male: 347.2±9.7 *vs*. 332.7±40.9, p=0.57; female: 351.8±21.7 *vs*. 323.5±38.3 %, p=0.27).

In terms of strength quality parameters, Table I shows that the bench press absolute strength of the medalists is more significant than that of the non-medalists (male: 70.0±10.7 vs. 66.7±27.4kg, p=0.85; female: 49.4±11.2 vs. 48.1±10.6kg, p=0.73), squat absolute strength is greater (male: 128.1±22.5 vs. 110.5±26.9kg, p=0.35; female: 119.0±26.2 vs. 90.1±20.4kg, p=0.44), higher squat weight (male:70.0±5.0 *vs*. 40.7±11.7 kg, p=0.04; female: 53.3±11.5 *vs*. 52.1±12.5 cm, p=0.89), higher jump height (male: 57.2±3.5 *vs*. 50.6±2.7 cm, p=0.01; female: 42.3±1.1 *vs*. 40.3±1.3 cm, p=0.04).

Table II shows that in terms of isokinetic muscle force parameters, under the test condition of 60°/s, the mechanical parameters of female athletes' knee joints are consistent, and the parameters of the right and flexor muscles are better, and there is no significant difference; For male athletes, flexor parameters were slightly larger on the left side, while extensor parameters were slightly larger on the right side. Among them, compared with the right side, the peak extensor moment (175.8±4.8 *vs*. 218.1±7.5N·m, p=0.01) and the relative peak extensor moment (3.13±0.57 *vs*. 3.89±0.72N·m/kg) of male athletes were higher than that of the left side. p=0.01), peak flexor power (92.2±7.1 *vs*. 63.1±16.7W, p=0.01), peak extensor power (84.5±5.9 *vs*. 115.5±7.7W, p=0.01), peak relative extensor power (76.5±6.1 *vs*. 104.5±6.5W, p=0.01), and relative peak flexor power (84.0±7.2 *vs*. 73.5±11.5W, p=0.02).

Under the test condition of 180°/s, the mechanical parameters of female athletes' knee joints were slightly higher on the right side than on the left side, and the flexor muscle was slightly higher than the extensor muscle. The peak power of flexor muscle was (112.7±10.7 *vs*. 131.2±6.1W, p=0.01), and relative extensor peak power (124.6±8.7 *vs*. 140.1±17.8W/kg, p=0.01) were significantly different. Peak extensor moment (96.8±8.3 *vs*. 107.5±13.4N·m, p=0.04), peak extensor power (138.3±10.5 *vs*. 157.3±20.4W, p=0.02), and relative flexor peak power (100.5±10.8 *vs*. 114.9±7.2W/kg, p=0.02) were significantly different. The flexor parameters of male athletes were better on the right side, while the extensor parameters were slightly higher on the left side. Among

Table I. Physical fitness parameters of elite and ordinary Chinese Teenage freestyle skiing aerials athletes.

	Male teenage athletes			Female teenage athletes		
	Elite (n=3)	Ordinary (n=7)	P	Elite (n=3)	Ordinary (n=7)	P
Age (years)	16.7±0.6	15.4±2.2	0.38	16.3±1.5	15.9±2.1	0.74
Height (cm)	170.7±4.9	169±9.2	0.78	167.0±6.6	161.9±5.7	0.24
Weight (kg)	59.3±2.9	56.5±9.2	0.63	58.7±2.2	52.5±7.5	0.07
Body fat percentage (%)	8.7±0.1	11.4±1.9	0.03 *	18.4±4.4	21.4±4.7	0.33
Lower limb length percentage (%)	53.4±1.1	51.8±1.1	0.07	53.4±0.9	51.4±1.5	0.66
Achilles tendon length (cm)	20.2±0.7	20.4±2.0	0.87	17.4±2.5	17.2±2.7	0.93
Waist circumference (cm)	69.4±2.6	70.5±1.8	0.42	77.5±2.4	72.3±5.4	0.16
Quetelet index	347.2±9.7	332.7±40.9	0.57	351.8±21.7	323.5±38.3	0.27
Absolute strength of bench press	70.0±10.7	66.7±27.4	0.85	49.4±11.2	48.1±10.6	0.73
Absolute strength of squat (kg)	128.1±22.5	110.5±26.9	0.35	119.0±26.2	90.1±20.4	0.44
Power clean (kg)	70.0±5.0	40.7±11.7	0.04 *	53.3±11.5	52.1±12.5	0.89
Depth jump (cm)	57.2±3.5	50.6±2.7	0.01 *	42.3±1.1	40.3±1.3	0.04

them, the peak moment of the left and right extensor muscles (138.7±8.1 *vs.* 114.7±4.8N·m, p=0.01), the peak power of the extensor muscles (196.0±14.3 *vs.* 157.3±5.0W, p=0.01), relative peak power of extensor (181.0±15.3 *vs.*143.5±11.5W, p=0.01), and peak torque of flexor (89.7±5.0 *vs.* 96.5±9.0N·m, p=0.04) and relative peak torque of extensor (2.47±0.48 vs. 2.05±0.39N·m/kg, p=0.04) were significantly different.

Table III shows that in terms of hip joint muscle force parameters, the adductor strength of the hip joint is slightly more prominent on the right side, while the abductor strength and hamstring muscle strength are slightly more prominent on the left side. In female athletes, the left side of the hip muscle is better, and the hamstring strength is significantly greater than the right side (297.4±34.0 vs. 262.2±39.5N, p=0.04).

Table II. Comparison of knee joint isokinetic torque parameters between left and right sides in adolescent freestyle skiing aerials.

Test indicators		Male teenage athletes (n=10)			Female teenage athletes (n=10)		
		Left	Right	P	Left	Right	P
60°/s	Peak flexion torque (N·m)	132.7±6.5	128.2±9.8	0.24	98.1±6.0	99.8±12.4	0.70
	Peak extension torque (N·m)	175.8±4.8	218.1±7.5	0.01 * *	151.5±21.2	157.2±16.5	0.51
	Relative flexion torque (N·m/kg)	2.37±0.03	2.29±0.47	0.70	1.83±0.26	1.85±0.25	0.86
	Relative extension torque (N·m/kg)	3.13±0.57	3.89±0.72	0.02 *	2.81±0.41	2.92±0.36	0.55
	Flexion peak power (W)	92.2±7.1	63.1±16.7	0.01 * *	69.9±6.3	72.2±9.8	0.55
	Extension peak power (W)	84.5±5.9	115.5±7.7	0.01 * *	80.9±8.3	83.6±11.4	0.54
	Relative flexion power (W/kg)	84.0±7.2	73.5±11.5	0.02 *	63.9±4.9	65.2±9.9	0.72
	Relative extension power (W/kg)	76.5±6.1	104.5±6.5	0.01 * *	77.2±8.1	78.9±11.0	0.70
180°/s	Peak flexion torque (N·m)	89.7±5.0	96.5±9.0	0.04 *	73.0±9.7	79.3±4.6	0.08
	Peak extension torque (N·m)	138.7±8.1	114.7±4.8	0.01 * *	96.8±8.3	107.5±13.4	0.04 *
	Relative flexion torque N·m/kg)	1.60±0.31	1.72±0.36	0.43	1.36±0.19	1.48±0.19	0.17
	Relative extension torque (N·m/kg)	2.47±0.48	2.05±0.39	0.04 *	1.80±0.22	2.00±0.28	0.10
	Flexion peak power (W)	148.0±17.4	158.0±22.5	0.28	112.7±10.7	131.2±6.1	0.01 * *
	Extension peak power (W)	196.0±14.3	157.3±5.0	0.01 * *	138.3±10.5	157.3±20.4	0.02 *
	Relative flexion power (W/kg)	129.0±16.7	140.5±23.6	0.22	100.5±10.8	114.9±7.2	0.01 * *
	Relative extension power (W/kg)	181.0±15.3	143.5±11.5	0.01 * *	124.6±8.7	140.1±17.8	0.02 *

Table III. Comparison of hip joint muscle strength between left and right sides in adolescent freestyle skiing aerials.

Test indicators	Male teenage athletes (n=10)			Female teenage athletes (n=10)		
	Left	Right	P	Left	Right	P
Hip adduction strength (N)	368.1±110.6	381.7±97.0	0.77	365.3±35.7	354.2±49.4	0.57
Hip abduction strength (N)	330.7±66.0	323.1±60.7	0.79	322.4±52.4	320.8±42.1	0.94
Hamstring tendon strength	326.7±72.3	318.4±84.8	0.82	297.4±34.0	262.2±39.5	0.04 *

DISCUSSION

As shown in Table I, the medalists exhibit the characteristics of older age, taller height, a more significant proportion of lower limb length, relatively more considerable body weight, a lower percentage of body fat, and a more extensive Quetelet index. The older age means longer training years and richer competition experience. Height, lower limb length ratio, and other parameters directly affect the quality of athletes' maneuvers in the air. A longer lower limb ratio can make the movements smoother and more prominent and is conducive to jumping movements' extension and landing stability. Higher height, more significant weight, lower body fat percentage, and more extensive Quetelet index indicate that the winning athletes have larger muscle mass, laying a better foundation for strength quality. Lower body fat percentage is beneficial to reduce air resistance, improve the quality of technical movements, and save energy consumption so athletes can complete complex movements more easily.

Yao & Niu (2023), pointed out that Achilles tendon length and waist circumference are the key indicators to evaluate the body shape of aerial skill athletes. Among them, Achilles tendon length is highly correlated with the explosive force of athletes' lower limbs, which determines the cushioning force and stability of athletes during landing. Under the premise of controlling body fat percentage, the athlete's waist circumference determines the cross-sectional area and strength of the lumbar abdominal muscle. The lumbar abdominal muscle is the key muscle group that drives the air rotation, flips, and controls body movement. The strong core area control power can also effectively reduce the risk of spinal and knee injury. Table I shows that the Achilles tendon length of medalists is almost the same compared to non-medalists. However, the waist circumference of men is slightly smaller, and women's is slightly larger, which may be related to adolescent athletes' growth and development characteristics.

Xu *et al*. (2022), believe that freestyle skiing aerials have high requirements for athletes' explosive power, coordination, perception, and control ability, and good physical fitness becomes an important guarantee for athletes to improve their unique athletic ability and reduce sports injuries. In the push and stretch stage at the late stage of take-off and landing buffering, the rapid strength of the lower limbs and trunk extensor muscles under centripetal contraction is crucial. In the landing buffering stage, the rapid centrifugal contraction of the extensor muscles of lower limbs is relied on to absorb the impact load and the size of the rapid centrifugal force plays a decisive role in landing stability. Table I shows that while male and female medalists did not show significant differences in absolute bench press and squat strength compared to non-medalists,the medalists had more excellent mean absolute bench press and squat strength.

In addition, the test results of male athletes' depth jump (p=0.01) showed very significant differences, the test results of power clean (p=0.04) showed significant differences, and the test results of female athletes' depth jump (p=0.04) showed significant differences. The results of power clean were also better, indicating that the explosive power of lower limbs and trunk and the synergistic power of the two are the key factors affecting the competitive performance of aerials athletes. In addition, Wei *et al*. (2022, 2023), showed that core stability training can help improve the landing performance of aerials athletes and prevent sports injuries. Therefore, young Chinese aerials athletes should focus on training for such strength quality. In practice, squats, power clean, depth jumps, sitting medicine ball side throwing, and body functional training can be used to develop athletes' lower limb and trunk strength quality. At the same time, bio-mechanical and kinematic instruments and equipment can capture the left and right side speed, explosive force, reaction time, activity, and other data during the landing phase to improve the efficiency of physical training.

Using isokinetic muscle force to test the strength parameters of the hip, knee, ankle flexor, and extensor muscle group of the athletes in the aerials can scientifically diagnose the shortboard of the athletes' exceptional strength to formulate targeted training plans to develop their exceptional strength quality when 60°/s is mainly tested the maximum strength of the joint muscle group and the balance of the muscle force. In contrast, 180°/s is mainly tested for the strength endurance of the joint muscle group. Harput *et al*. (2020), pointed out that muscle power imbalance and fatigue are the leading causes of joint injury and landing failure. Power imbalance usually occurs between each joint's flexor and extensor muscle groups, between fast and slow contractions, between centripetal and centrifugal contractions, and between sides.

Lou *et al*. (2022), pointed out that Chinese elite aerials athletes have prominent concentric and eccentric forces in the main joints, balanced flexor and extensor muscles, and good symmetry of muscle forces on the left and right sides of the hip and knee joints. Elite athletes' major joint muscle strength is most affected by contraction mode, followed by movement speed. In the fast contraction mode, the peak torque of eccentric contraction is more significant than concentric contraction, and the strength of the fast extensor muscle group is the core index affecting athletic performance. Tables II and III show that under different speed tests, all the mechanical parameters of the knee joint of Chinese young freestyle skiing aerials female athletes show a consistency characteristic that the right side and flexor muscle are slightly larger, while the left side strength parameters of the hip joint are better. There is no consistency between the knee joint and the hip joint of male athletes in different parameters and different sides. The results indicate that the joints' primary flexor and extensor muscle groups and the mechanical parameters of left and right muscle groups are generally unbalanced in Chinese young aerials athletes.

Concerning the mechanical parameters and characteristics of excellent Chinese aerials athletes, Chinese young aerials athletes should strengthen the extensor muscle strength of the main joints, further improve the balance of flexor and extensor muscle groups on both sides, adductor and abductor muscle groups of the hip joint, and hamstring muscle force. Focusing on the development of the concentric contraction strength of athletes should focus on strengthening the athlete's leading joint muscle group, including rapid eccentric contraction strength, hip joint rotation strength, trunk deep muscles, and minor muscle group strength training. At the same time, we can use the trampoline, bungee training, gymnastics mat action training, and summer pool training to optimize the proprioception and quality of athletes' essential aerial and landing technical movements.

CONCLUSION

Compared with non-medalists, medalists are taller and heavier, with a lower body fat percentage, a more significant proportion of lower limb length, and a more extensive Quetelet index. The results of bench press, squat absolute strength, power clean, and depth jump are better, which indicates that in the selection and physical training of young freestyle skiing aerial athletes, attention should be paid to the above body morphology indicators, as well as the development of athletes' upper and lower limb essential strength, explosive power and coordination of trunk and lower limb and other key strength qualities. In addition, there are primary joint flexor, extensor muscle group, left and right muscle group power imbalance problems, which should enhance the strength of athletes' trunk fast flexor, extensor muscle group, knee joint fast, concentric, and eccentric forces, as well as hamstring strength, and optimize the balance of left and right side strength.

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RESUMEN: Este estudio analizó la forma corporal, los parámetros de fuerza y las características de jóvenes atletas chinos de esquí acrobático y propuso las estrategias de entrenamiento correspondientes. Se seleccionó a veinte atletas participantes en la competición China de esquí acrobático U-series. Los índices de prueba incluyeron altura, peso, porcentaje de grasa corporal, porcentaje de longitud de miembros inferiores, longitud del tendón calcáneo, perímetro de cintura, índice de Quetelet, fuerza máxima en press de banca y sentadilla, cargada de potencia, salto en profundidad, fuerza isométrica de la articulación de la rodilla y fuerza muscular de la articulación de la cadera. Los atletas premiados eran más altos y pesados, presentaban un menor porcentaje de grasa corporal, un porcentaje más significativo de longitud de los miembros inferiores y un índice de Quetelet mayor que los atletas no premiados. Los resultados en press de banca, sentadillas, cargada de potencia y salto de profundidad son mejores, lo que indica que la fuerza base de los miembros superiores e inferiores, la potencia explosiva del tronco y los miembros inferiores, y la sinergia entre ellas, son cualidades clave que afectan el rendimiento competitivo de los jóvenes atletas de saltos aéreos. Los jóvenes atletas chinos de saltos aéreos generalmente presentan un desequilibrio de potencia en los grupos musculares flexores y extensores de las articulaciones primarias, así como en los grupos musculares izquierdo y derecho. Esto debería fortalecer los grupos musculares flexores y extensores rápidos del tronco, las fuerzas concéntrica y excéntrica rápida de la rodilla y la fuerza de los músculos del compartimiento posterior del muslo, optimizando así el equilibrio de fuerza entre ambos lados.

PALABRAS CLAVE: Esquí acrobático; Morfología; Fuerza; Antropometría; Jóvenes atletas.

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Corresponding author:
Ping Gao, PhD
Research Center for Innovative Development in Sports and Health
College of Sport Training
Wuhan Sports University
461 Luoyu Road
Hongshan District
Wuhan, Hubei
CHINA

E-mail: gp8882587@163.com

ORCID: 0000-0002-5401-3419