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# Development of A Comprehensive Test for Talent Identification in Chinese Youth Racewalking Athletes

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**Abstract**

**Background and Aim:** Talent identification forms the foundation of competitive sports. Scientific selection of young people with strong athletic talent and potential to compete in sports training is key to developing high-level athletes and achieving excellent athletic results. Therefore, this study aims to develop a comprehensive test for talent identification in Chinese youth racewalking athletes.

**Materials and Methods:** This is a research and experimental development (R&D) study. There are approximately 300 youth racewalkers in China, and this study is implemented in 115 athletes. The main steps and methods of the study are as follows: (1) Literature review and content analysis, search and sort out the factors related to excellent racewalking performance; (2) Invite 7 experts to fill in the semi-structured questionnaire and form a preliminary draft of the comprehensive test; (3) Invite 21 experts to conduct a Delphi evaluation of the comprehensive test content and revise the comprehensive test; (4) Implement the comprehensive test and analyze the data, select the key test through correlation analysis, and conduct a Test-retest analysis to confirm test reliability; (5) Complete the second round of Delphi evaluation and to construct the final comprehensive test and norms.

**Results:** The final comprehensive test for talent identification in Chinese youth racewalking athletes includes five aspects: anthropometric, physiological, physical fitness, skill, and psychology. The comprehensive test for males included 11 items as follows: (1) Pelvic Width; (2) Thigh Length; (3) Calf Length; (4) $VO_2$ max; (5) 400m Run; (6) 3000m Run; (7) 1000m Racewalking; (8) Sit and Reach; (9) Willpower; (10) Mental Resilience; and (11) Expectation of Winning. The comprehensive test for females included 8 items as follows: (1) Thigh Length; (2) Calf Length; (3) $VO_2$ max; (4) 400m Run; (5) 1000m Racewalking; (6) Standing Long Jump; (7) Willpower; and (8) Motivation to Participate.

**Conclusion:** The holistic evaluation of Chinese youth racewalking athletes encompasses a diverse range of factors, from physical dimensions to psychological attributes, reflecting a nuanced understanding of talent beyond mere physical prowess.

**Keywords:** Youth Racewalking Athletes; Talent Identification; Comprehensive Test

## Introduction

In March 2021, the Chinese State Council released two important documents, the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of Long-term Goals for 2035. These documents clearly state the need to strengthen the training of reserve talent for competitive sports, improve the competitive level of key events, and consolidate the advantages of traditional events (Xinhua News Agency, 2021). Furthermore, the 14th Five-Year Plan for Sports Development from the General Administration of Sport of China emphasizes the importance of setting up scientific and technological support for training and research teams, building a sports training database, and strengthening the construction of the youth training model (State Council of the People's Republic of China, 2021). Although the 20th National Congress of the Communist Party of China only briefly mentions sports, its report once again highlights the significance of competitive sports as a pillar of national power. By doing so, we can lay a solid foundation for the training of competitive sports talent, standardize the collection and analysis of data for talent selection and training, and provide guidance for the development of sports.

As we all know, selecting and developing excellent youth racewalkers is crucial to maintaining the leading position of this sport. Therefore, to implement the Olympic Glory Winning plan and address new challenges in developing track and field events in China, we must construct a comprehensive talent identification model. This scientific and inclusive model is expected to select and evaluate Chinese youth



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racewalking athletes and provide a foundation for the scientific and sustainable growth of Chinese racewalking events. Furthermore, we hope our model can serve as a reference for selecting other competitive events. During our literature review, we discovered that while research on the selection and evaluation of racewalkers has been ongoing, recent references are limited. Early scholars mainly discussed selective training of racewalking from a single dimension, such as heart rate (pulse) (Zhou & Ma, 2003), special ability index, and body form (Hua et al, 2007; Hua Li & Mou Shaohua, 2008). Subsequently, scholars have been more inclined towards a multidimensional approach. Wang (2004) proposed that racewalking technique, cardiopulmonary function, and physical fitness should be key factors in the selection test indexes of youth racewalkers. Zhang Shihao (2002) suggested that the selection of race-walking athletes should consider a long body, relatively lightweight, flexibility, and endurance of hip and ankle joints, as well as a longer proportion of lower limbs. According to Li (2018), comprehensive consideration should be given to athletes' physical form, quality level, function level, and special skills in the selection stage. Yoshida T.et al. (1989) put forward the aspects of body composition, body form, physiology, biochemistry, and psychology in the research on the selection of young female racewalkers in plateau areas and suggested establishing a database of Chinese female racewalkers living in the plateau.

Furthermore, many scholars have recognized the importance of developing comprehensive models (combined anthropometric, physiological, physical fitness, biomechanics, psychological, and other dimensions), with similar content such as Zhang Xiaoliang's (2008) research on the special physical quality evaluation model of Chinese elite female racewalkers identified five levels of special physical quality: special speed factor, special speed endurance factor, special endurance factor, special long time endurance factor, and special super long time endurance factor. These five factors reflect the athletes' unique physical qualities, and the index is tested by different distances of racewalking. Chen (2016) added physical ability tests such as push-ups, dangling leg lifts, hip rotations, and heel lifts based on different distance results as tests. These studies mainly focus on one aspect, and the sample size is small, which significantly limits their conclusions. Based on the evolutionary process and conclusion of previous research, it is recommended that the selection of racewalkers may need to consider a range of factors, including body shape, basic physical qualities, special abilities, physiological, biochemical, and so on. At present, the Chinese racewalking community lacks a comprehensive and scientifically based model for identifying athletic talent.

Talent identification forms the foundation of competitive sports. Scientific selection of young people with strong athletic talent and potential to compete in sports training is key to developing high-level athletes and achieving excellent athletic results. Evaluating and predicting talent during the cultivation process are also essential components of sports training and physical education. Therefore, this study aims to construct a comprehensive test for talent identification in Chinese youth racewalking athletes by exploring factors and tests that may be associated with better racewalking performance. The entire research process will involve expert interviews, questionnaire surveys, experimental tests, and data analysis to gradually identify key factors and refine the test model.

## Objectives

Main objectives

To develop a comprehensive test for talent identification in Chinese youth racewalking athletes.

Subsidiary objectives

1. To explore factors and tests that are associated with better racewalking performance.
2. To collaborate with experts in identifying and screening these factors and test methods, leading to the construction of a comprehensive test.
3. To carry out validity and reliability analyses of the test.
4. To implement the comprehensive test and establish norms.

## Literature Review

### 1. Racewalking

1.1 Introduction of racewalking

Racewalking traces its origins back to the year 1880, with its initial appearance in the athletics



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competitions of the Amateur Athletics Association in the United Kingdom. It formally debuted in the modern Olympic Games in 1904, initially as a half-mile racewalking event within the all-around sports category, laying the groundwork for subsequent standalone events. Over time, racewalking has evolved into prominent 20-kilometer and 50-kilometer events and has cultivated a dedicated following and enjoys popularity in numerous countries globally. It stands out as a physically demanding sport, necessitating athletes to diligently train to enhance their technique, endurance, and speed. The rules of the racewalking program are strict, athletes are required to sustain continuous contact with the ground and ensure that their leading leg remains straight from the moment it makes contact with the ground until it is positioned beneath the body. To be specific, racewalking is governed by two crucial regulations. The first stipulates that the toe of the trailing foot must not lift from the ground before the heel of the leading foot makes contact, violation of this rule is deemed as "loss of contact" and a large number of studies have pointed out that: less than 0.042s is the reasonable air time limit in racewalking, 0.042-0.070s is the fuzzy time limit, and greater than 0.070s is the foul air time limit (air time is calculated by dividing 120 by the number of frames taken by athletes from one foot off the ground to the ground with the other foot) (Zhang, 2019). The second rule mandates that the leading foot must land with a straight leg, prohibiting any bending at the knee; contravention results in classification as a "Bent Knee". Adherence to these regulations is closely monitored by judges and high-speed cameras, with infractions potentially resulting in disqualification.

The scope of racewalking events encompasses a diverse range of distances, from the short-distance 3,000-meter race walk (an official event in the 1920 Summer Olympics) to the endurance-demanding 100-kilometer race walk. The formal record for the longest distance is held by the 50-mile (80.5 kilometers) race walk. The fastest official record for the men's 50-mile race walk was achieved by Israeli athlete Shaul Ladany in 1972 in New Jersey, completing it in 7 hours 23 minutes, and 50 seconds, breaking records dating back to 1935. In the official events of the modern Olympic Games, the predominant racewalking categories are the 20-kilometer race walk (for both men and women) and the 50-kilometer race walk (exclusive to men). The world of athletics saw the inclusion of the women's 50-kilometer race walk event only in the year 2017. Racewalking competitions take place on roads, tracks, or designated racewalking courses, contingent upon the nature of the competition, and the International Association of Athletics Federations (I.A.A.F) governs international racewalking, overseeing rule formulation and competition organization. In addition, this athletic pursuit offers multifaceted benefits, not only is it joint-friendly and conducive to cardiovascular health, but also aids in weight control and serves as a stress-relieving activity. Additionally, it fosters social interaction, providing opportunities for athletes to forge new connections (I.A.A.F, 2012).

1.2 Racewalking technique

Racewalking necessitates a specialized approach to maximize speed while adhering to the sport's regulations. Athletes concentrate on maintaining proper form, including a straightened leading leg, heel-to-toe contact, and avoiding any evident loss of contact. Specifically, the technical essentials of racewalking encompass (1) Posture and Stride: The fundamental posture in racewalking requires athletes to maintain an upright but slightly forward-leaning position. The stride must be robust, adhering to specified rules regarding heel-to-toe placement and ensuring the knee extends straight upon ground contact; (2) Arm Movement: Arm movements play a crucial role in maintaining balance and providing propulsion. Athletes need to swing their arms with a controlled range of motion, arm swings should occur at the sides of the body to coordinate with forward movement; (3) Hip Rotation: Hip rotation stands out as a pivotal action in racewalking. Swift hip rotation allows athletes to propel their bodies forward more efficiently, minimizing the risk of losing contact with the ground, this action demands a combination of balance and flexibility. (4) Breath Control: Effective breathing is paramount for endurance in long-distance athletic endeavors. Athletes must learn to control their breathing, ensuring an ample supply of oxygen to the engaged muscles. In summary, racewalking is a demanding and technically intricate athletic discipline. A systematic and persistent training regimen is imperative for athletes to master these technical intricacies. Proficiency in these technical facets empowers racewalkers to optimize their efficiency and speed (Ruhling & Hopkins, 1990).



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1.3 Racewalking in China

Racewalking stands out as a stronghold in the realm of Chinese Olympic sports. Since Liaoning athlete Chen Yueling clinched the first gold medal for China in the Barcelona Olympics in 1992, the Chinese racewalking team has amassed a noteworthy tally of 6 gold, 3 silver, and 6 bronze medals. Looking back, the Chinese national racewalking team rose to prominence on the global stage after 1992, experienced a decline in achievements after 2000, and then saw a resurgence in 2012. The athletic journey has not been without challenges, recognizing its pivotal role in medal acquisition, both the Chinese National Sports Administration and the Athletics Association place significant emphasis on talent identification and cultivation within the realm of racewalking. Simultaneously, there is a profound commitment to the promotion and organization of racewalking events. The recent surge in the popularity of "city walk" among the Chinese populace serves as compelling evidence of the comprehensive popularization of racewalking in the country.

**2. Talent racewalkers identify**

2.1 Key factors of talent Racewalkers identify

Technique Analysis: The racewalking technique plays a crucial role in performance. Video analysis can be used to assess an athlete's walking form, including leg straightening, heel-to-toe contact, and visible loss of contact, coaches or experts can evaluate the athlete's technique and provide feedback for improvement.

Speed and Endurance Tests: Various tests can assess speed and endurance in racewalking. These may include timed trials over specific distances, such as 1 kilometer or 10 kilometers, to measure how quickly an athlete can cover the distance while maintaining racewalking form. Endurance tests can involve longer distances, such as a 20-kilometer race, to evaluate an athlete's ability to sustain a fast pace over an extended period.

Gait Analysis: Gait analysis involves assessing an athlete's walking pattern, stride length, stride frequency, and other biomechanical parameters. This can be done using specialized equipment like force plates or motion capture systems to analyze the athlete's movement and identify areas for improvement.

Strength and Power Tests: Strength and power are important for racewalking performance. Tests can include measuring an athlete's lower body strength through exercises like squats or leg presses, as well as assessing power through vertical jump tests or horizontal power tests like standing long jump.

Aerobic Capacity Assessment: Aerobic fitness is critical for racewalking. Tests such as the $VO_2$ max test, which measures the maximum oxygen uptake, can provide insights into an athlete's cardiovascular fitness and endurance potential, other tests like the lactate threshold test can help determine an athlete's optimal race pace and training zones.

Flexibility Assessment: Flexibility is crucial for achieving optimal stride length and preventing injuries, tests like the sit-and-reach test can evaluate an athlete's lower body flexibility, especially in the hamstrings and hip area.

Psychological Assessment: Psychological factors, including focus, motivation, and mental resilience, can impact racewalking performance. Psychological assessments, interviews, or questionnaires can help evaluate an athlete's mental preparedness, goal-setting abilities, and coping strategies under pressure.

It's important to note that these tests and evaluations should be conducted by qualified professionals, such as coaches, sports scientists, or exercise physiologists, who have experience working with racewalking athletes. They can provide a comprehensive assessment and individualized feedback to improve performance based on the results obtained.

2.2 Measurement and evaluation of elite racewalkers

2.2.1 Anthropometric

The physical characteristics of elite racewalking athletes are mainly reflected in many aspects such as height, weight, pelvic width, Achilles tendon length, body fat percentage, thigh length, calf length, arm span, shoulder width, upper limb length, lower limb length, chest circumference, waist circumference, and hip circumference. Relevant research shows that the mean height, body mass, and body mass index of



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world-class racewalking athletes were 177.1±7.1 cm, 66.4±5.8 kg, and 21.2±1.3 kg·m2 for men and 165.6±4.5 cm, 53.6±3.7 kg, and 19.6±1.6 kg·m2 for women, respectively (Gomez-Ezeiza et al., 2019). In addition, a function of the shoulder torque was to counterbalance the torso torque to gain a fast walking speed with substantial mechanical energy flow (Espinoza-Navarro et al., 2019). In terms of body fat percentage, the body fat percentage of world-class racewalking athletes is between 6-10%, indicating lower body mass index and lower body fat content in racewalking athletes, the lower body fat percentage is beneficial to the performance of strength and endurance, which is an important characteristic for achieving excellent competitive results (Gomez-Ezeiza et al., 2018). In domestic research, Hua & Mou (2008) conducted a study on the physical characteristics of Chinese excellent youth female racewalking athletes. From the five aspects of length, symmetry, length ratio, arch height, and lower limb ratio, statistical analysis was carried out, and the following physical characteristics index of Chinese excellent youth female racewalking athletes were obtained: foot height, calf length + foot height, (calf length + foot height), lower limb length, weight/height × 1000, ankle circumference/lower limb length. Gomez-Ezeiza et al. (2019) found that the length of the lower limbs of excellent racewalking athletes accounts for 50-53% of their height, which is relatively high, the study also found that the thigh and calf lengths of racewalking athletes are 5-7% longer than those of ordinary people, this indicates that the length and proportion of the lower limbs are crucial to the competitive ability of racewalking athletes. In addition, racewalking athletes also exhibit characteristics such as a narrow pelvis, larger arm span, and relatively longer Achilles tendon. Among them, the longer Achilles tendon can produce greater propulsion force and achieve higher speeds; the wider arm span than ordinary people can effectively suspend and swing the arms during exercise, achieving a coordinated step frequency; and wider shoulders are also beneficial to the amplitude of arm swing. These characteristics are beneficial to producing greater propulsion force, achieving higher step frequency and stride, and improving exercise efficiency.

In summary, the physical characteristics of racewalking athletes are typical, and these characteristics are not only formed by long-term training of excellent racewalking athletes but are also the result of natural selection in response to the requirements of racewalking sports, anthropometric characteristics have an important impact on the athletic skills and competitive ability of racewalking athletes (Sun, 2011).

2.2.2 Physical Function (Physiology and Biochemistry)

Physical function is also one of the key factors that need to be considered in identifying athletes. For periodic endurance sports, because of the long distance and duration, most of the energy consumption is supplied in the form of aerobic energy supply. The ability to absorb and use oxygen is an important factor that determines the athlete's athletic ability. Therefore, the physical function indicators related to excellent endurance performance are crucial in identifying racewalking talents, which mainly include maximum oxygen uptake ($VO_2$ max), anaerobic threshold speed (VAT), testosterone levels, lung capacity, etc. Excellent physical function is an important guarantee for elite racewalking athletes to achieve world-class levels, racewalking places high demands on athletes' aerobic capacity and acid-base balance function. Maximum oxygen uptake ($VO_2$ max) is an important indicator for evaluating aerobic exercise capacity and is significantly positively correlated with racewalking performance, the $VO_2$ max of elite racewalking athletes can reach 70-80ml/kg/min (Sjodin & Svedenhag, 1985). Yoshida et al. (1989) conducted a study on the physiological factors of female racewalking athletes' walking ability and believed that excellent racewalking ability is closely related to $VO_2$-LT, V-OBLA (lactate threshold speed), $VO_2$-OBLA (lactate threshold maximum oxygen uptake), $VO_2$ max, and energy-saving. These indicators are highly correlated with 5KM racewalking ability, and V-OBLA is the best predictor of racewalking ability, followed by $VO_2$ max. Anaerobic threshold speed (VAT) is an important criterion for evaluating the aerobic threshold of aerobic exercise, and a faster VAT means that the body enters the aerobic state earlier, which is also closely related to racewalking performance (Liu, 2012). Nie, et al (2003) found that the VAT of world-class racewalking athletes is faster, reaching 14-16km/h, indicating their ability to enter the aerobic state earlier. On the other hand, maintaining a high concentration of hemoglobin in the body requires the involvement of substances such as testosterone, and a high level of cortisol is beneficial to regulating acid-base balance



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and coping with metabolic acidosis caused by long-term exercise (Ruhling & Hopkins, 1990). Hanley (2013) found that the testosterone level of world-class racewalking athletes is as high as 15-20 nmol/L, which is beneficial to regulating acid-base balance and extending aerobic exercise time. In addition, a higher level of cortisol is also helpful in regulating metabolic acidosis to adapt to long-term aerobic exercise (Jones & Carter, 2000). Excellent racewalking athletes also have larger lung capacity (Malina et al., 2004) and higher hematocrit (HCT), which lay the foundation for achieving higher $VO_2$ max and longer aerobic exercise time (Kaimal KP et al., 1993).

In summary, the outstanding physical function characteristics of racewalking athletes are reflected in their higher $VO_2$ max and VAT, larger lung capacity, hematocrit, testosterone, and cortisol levels. These features come from excellent racewalking athletes' long-term specialized training and genetic talent.

2.2.3 Physical Fitness

The physical fitness of racewalking athletes refers to the abilities obtained through specialized physical training methods and techniques closely related to the characteristics of racewalking events during training. Specialized qualities that are directly related to specialized sports include strength, speed, endurance, and other abilities. Obtaining these specialized sports abilities can ensure that athletes better master specialized techniques and tactics during training and apply them effectively in competitions (Dong & Cang, 2009). However, currently, there are very few indicators of physical fitness used for talent identification in racewalking events, and systematic research and testing of these indicators are rare. Hua & Mou (2008) conducted a relatively representative study, in which they divided the indicators of quality into specialized endurance (5000m run), specialized speed (400m racewalking), and specialized strength (standing long jump, sit-ups, waist and back muscle exercises, and push-ups). Liu & Wang (2009) used a large correlation analysis method to comprehensively analyze the 26 physical fitness indicators of 30 outstanding female racewalking athletes in China and divided the specialized physical fitness indicator system of excellent female 5000m racewalking athletes in China into nine levels, including specialized speed, specialized speed endurance, specialized endurance, specialized long-term endurance, and specialized ultra-long-term endurance. Hu & Zhai (2009) also researched the training characteristics of Chinese outstanding racewalking athletes in Olympic preparation years and pointed out that according to the characteristics of racewalking events, athletes' specialized sports abilities should highlight their specialized endurance, speed endurance, and specialized speed. Generally, racewalking training develops specialized endurance through long-term continuous walking, develops specialized speed through fast walking and variable speed walking, and develops speed endurance through interval walking to improve athletes' competitive ability. Based on the above research, it can be seen that speed ability can be evaluated using the 400-meter racewalking event, and excellent athletes can complete it within 1 minute and 30 seconds (Liu & Wang, 2009). Strength is represented by a long-standing long jump distance, a higher number of push-ups, and a maximum load of squats (Hua et al, 2007). Specialized endurance is one of the most important abilities of racewalking athletes, which can be evaluated by longer walking or running times. Faster 3000-meter running times and better 5000-meter racewalking results (Hu & Wang, 2010). In addition, strong abdominal and back muscle endurance can help maintain a stable posture and rhythm, racewalking athletes use a lot of interval training and variable speed walking in their training, which requires strong speed endurance ability (Gómez Eceiza, J, 2019).

In summary, it is crucial to scientifically test and understand the physical fitness characteristics of racewalking athletes to identify and develop world-class athletes. This requires in-depth research from the perspectives of biomechanics, exercise physiology, and training science to provide theoretical support and practical guidance for the further improvement of racewalking in China.

2.2.4 Psychological Qualities

In the process of athlete talent identification, it is necessary to fully recognize the important role of psychological factors in the individual's realization of their athletic potential, and similarly, psychological factors play a very important role in the racewalking sport. Racewalking is a speed endurance event with high technical requirements, from a high-level reserve talent to an international athlete, racewalkers are



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required to have a highly developed psychological endurance due to the nature of the event itself. Racewalking can even be said to be the most tedious and arduous among the 47 events in world athletics, the technical structure of racewalking is simple but with high technical requirements, and technical training must be arranged in training sessions. Racewalkers should have superhuman patience to endure extreme physical and mental fatigue, only with strong willpower can athletes meet the needs of training and competition (Zhou, 2016).

Wang (2004) pointed out that strong character, high emotional stability, strong self-confidence, good self-monitoring, no fear of difficulties, and a spirit of enterprising are the psychological characteristics of excellent racewalkers. Moreover, He believed in the article "Analysis of the Main Competitive Abilities of China's High-Level Racewalking Athletes at Present" that the psychological qualities that affect China's excellent racewalkers mainly include willpower, concentration, self-confidence, self-control, and the ability to withstand the psychological pressure of competition, especially the comprehensive psychological qualities of willpower, self-confidence, and the ability to withstand the psychological pressure of major competitions (Wang, 2007). Wang et al (2009) conducted a study on the psychological training structure of China's excellent male 20km racewalking athletes, by using psychological scale testing, interview methods, and mathematical statistics, 42 male 20km racewalking athletes were tested, and the core psychological training elements of excellent male 20km racewalking athletes in China were determined to be tenacity, decisiveness, sports motivation, internal motivation, and clear goals. The important psychological training elements include discrimination principles, and the auxiliary psychological training elements include the expectation of winning, tenacity, lack of motivation, and self-control, among which willpower has a core position and role in the psychological training structure of male 20km racewalking athletes, and sports motivation plays an important role. Hu Hao and Wang Chuanping (2010) conducted a study on the psychological training structure and training strategies of China's excellent female 20km racewalking athletes, by using psychological scale testing, interview methods, and mathematical statistics, 35 female 20km racewalking athletes in China were tested, and the core training elements of excellent female 20km racewalking athletes were determined to be tenacity, the expectation of winning, internal motivation, and clear goals. The important training elements include sports motivation, personal orientation, tenacity, self-control, and discrimination principles, the auxiliary training element is decisiveness, among them willpower is a strong vector, and sports motivation is a secondary strong vector. Jing (2010) pointed out that strengthening the cultivation of racewalking athletes' psychological qualities has special significance for modern racewalking training in establishing the belief and desire to climb to new heights in the multi-year training process. The content of basic training stage and primary specialized stage exercises has novelty and interest, and the methods and means are rich and diverse; in the specialized improvement training stage and advanced specialized stage, the focus is on improving the psychological qualities of athletes to overcome difficulties; the psychological training of racewalking athletes should follow the rules of the athletes' physical and mental development, personal psychological characteristics, age, and mastery of sports skills, and psychological training should be gradual, combining physical training, specialized skills, and tactical training organically, coordinated cooperation and consistent goals between coaches and athletes can achieve good results.

In summary, to become an excellent racewalking athlete, good psychological abilities such as willpower and sports motivation are prerequisites for achieving outstanding athletic performance. Therefore, it is of utmost importance to cultivate and develop the sports motivation and willpower of China's high-level racewalking reserve talents, coaches should include training content on cultivating athletes' sports motivation and willpower in their annual training plans.

Through a literature review of relevant studies, we can find out that there may be several factors related to racewalking performance, and through multi-dimensional exploration of the competitive ability characteristics of elite racewalkers, we can provide a theoretical basis for the construction of a scientific selection and evaluation system for youth racewalkers athletes.



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## Conceptual Framework

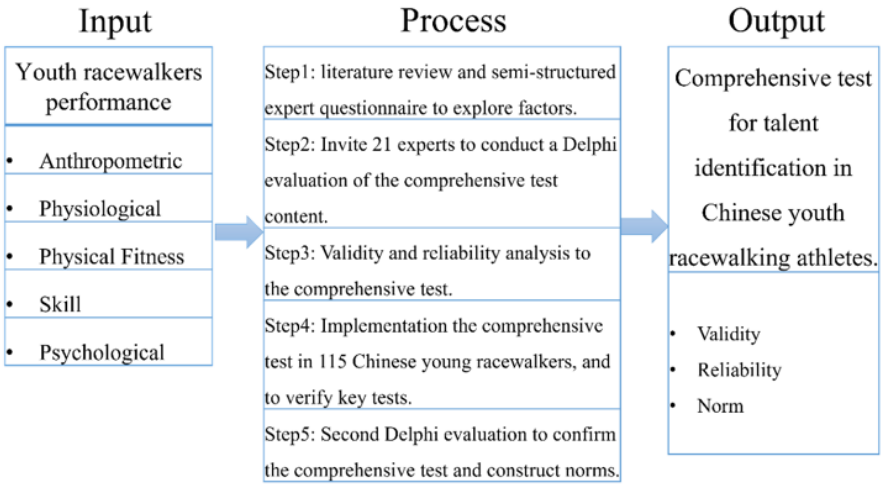


Figure 1 Conceptual framework of this research

## Methodology

### Research Tools

(1) The main test instruments in this study are the set of tests in constructed comprehensive tests including anthropometric test instruments, physiology test instruments, physical fitness test instruments, racewalking skill test instruments, psychological testing instruments, and data analysis instruments.

(2) Semi-structured questionnaire form for 7 experts.

(3) 2 rounds questionnaire for consensus by the Delphi technique.

(4) The primary test equipment used in this study included questionnaires, stopwatches, tape measures, yoga MATS, an Inbody composition analyzer, questionnaires, treadmills, a Portable cardiopulmonary function instrument (COSMED K5), and other necessary exercise training and test manual/form equipment.

### Population and Sample

The subjects of this study include two types of individuals: experts and athletes. Among them, experts include scholars familiar with racewalking, managers, professionals proficient in sports measurement and evaluation, as well as coaches at the provincial team level and above specializing in racewalking. The athletes are youth racewalkers aged 15-19 from China.

Based on this, we invited a total of 28 experts, who were divided into two groups. The first expert group consisted of 7 members, including 4 track and field experts who specialized in racewalking, 2 international racewalking coaches, and 1 national racewalking coach. This group included 5 Chinese experts and 2 Thai experts. The second expert group invited 21 members, including 6 track and field experts specialized in racewalking or former racewalkers, 5 experts in sports measurement and evaluation, and 10 racewalking coaches at the provincial level or above. They are familiar with the racewalking project in China, understand the measurement and evaluation methods and instruments for athletes, and have long been engaged in talent selection and development of youth racewalking athletes.

The target population of this study is Chinese youth racewalking athletes aged 15-19. This group consists of about 300 individuals in total and mainly comes from the central and western regions of China, some individuals possess athlete-level certificates issued by the General Administration of Sport of China, while the majority of individuals are at a beginner level in racewalking. The selection of the experimental subjects is based on snowball sampling, recommended, and introduced by coaches and team members. There were 115 participants in total. Before the test, we conducted a test of the gender and age distribution of the sample to determine that there was no significant difference in the number of test subjects (males and females) in different age groups.



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**Data Collection**

Literature review

Use keywords such as “racewalking”, “endurance sports”, “the selection of athletes”, “talent identification”, “material selection index system”, “cultivating youth talents for competitive sports” etc. to search for relevant literature such as books, journals, newspapers, thesis, dissertation, through electronic resources databases, national library, and Athletics Sports Management Center of the General Administration of Sport of China, and other resources.

Questionnaire survey

This study distributed a total of 4 questionnaires. The first semi-structured questionnaire was targeted at 7 members of the first expert group, with the main purpose of selecting and evaluating the indicators for talent identification and development in Chinese youth racewalking. The second Delphi questionnaire was mainly used to screen the measurement factors, excluding the factors with low expert evaluation or significant differences. The third questionnaire primarily targeted 5 Chinese members in the first expert group, with the main purpose of conducting an IOC evaluation of the final testing plan's validity. The fourth questionnaire was distributed to 115 Chinese youth racewalkers, with the main purpose of measuring and evaluating their psychological characteristics. This study mainly used the following scales: “Sports Motivation Scale” (Zhang, 2002), “Expectancy of Success Scale” (Pezer & Brown, 1980), “Elite Athlete Will Quality Scale” (Liang, et al, 2005), and “Youth Psychological Resilience Scale” (Hu & Gan, 2008).

Delphi method

This study has invited 21 experts for 2 rounds of Delphi to reach a consensus. The first round of Delphi expert consultation was conducted in the early stage of comprehensive test construction. After the test implementation, the second round of Delphi expert consultation was held.

Implementation test

After a literature review, an expert semi-structured questionnaire survey, and the Delphi method, the final comprehensive test for talent identification in Chinese youth racewalking athletes has been formed. The athlete testing plan is divided into several categories: (1) Field testing (conducted on the track and field); (2) Indoor testing (conducted in a spacious indoor area) includes testing with a weighing scale, height measuring tool, body fat analyze, yoga mat; (3) Laboratory testing ($VO_2$ max test) with the results recorded by laboratory personnel in an electronic spreadsheet; and (4) Questionnaire testing distributing and collecting data through paper questionnaires.

**Data Analysis**

Delphi analysis: invited 21 experts and used 2 rounds of the Delphi method to rate the importance of each test on a 5-point scale (where 5 means “very important”, 4 means “important”, 3 means “neutral”, 2 means “unimportant”, 1 means “very unimportant”). We will focus on the median and interquartile range (IQR): if the median of an indicator is less than 3.00 or the IQR is greater than 2.00, then this specific indicator will be removed.

Descriptive statistical: mainly analyzes the concentration level, dispersion tendency, distribution status, and other contents of the data one by one.

Relevance test: Before conducting the analysis, we first tested whether each variable follows a normal distribution. Secondly, during the analysis process, we conducted a test for homogeneity of variances. For the correlation test between two continuous variables, we refer to the Pearson correlation coefficient for variables that follow a normal distribution and the Spearman correlation test for variables that do not follow normality. For the correlation test between a continuous variable and a categorical variable, we used a one-way analysis of variance. For the correlation test between two categorical variables, we used chi-square analysis (cross-tabulation).

Reliability (Test-retest data analysis): conducted repeated measurements on half of the total population (57 people) and used the Pearson coefficient to test the correlation between the data of the first test and the second test for each test item.

## Results

### 1. Exploration of factors influencing racewalking performance

After conducting a comprehensive analysis of relevant literature, researchers have meticulously



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compiled a compendium of potential determinants that may be intrinsically linked to better racewalking performance. The corresponding literary evidence reveals several key findings as follows:

1) Anthropometric analysis suggests that elite racewalkers tend to exhibit a lower body fat percentage, longer Achilles tendons, narrower pelvis width, greater flexibility in hip joints, and longer lower limbs.

2) Physiological analysis indicates that outstanding racewalkers typically demonstrate robust cardiorespiratory function, efficient aerobic metabolism, substantial muscle strength, and exceptional coordination.

3) Analysis of sports specialization ability reveals that top-tier racewalkers generally maintain a stable sports posture, employ a higher step frequency, and utilize longer stride lengths compared to the general population.

4) Psychological quality analysis suggests that talent identification criteria may need to emphasize personality traits such as composure and resilience. Elite athletes often exhibit strong mental fortitude and unwavering determination.

**2. Semi-structured questionnaire with 7 experts**

The researcher meticulously developed a semi-structured questionnaire for an expert consultation, which was then presented to the first expert group. After gathering insights from 7 distinguished experts, the researcher synthesized and amalgamated these professional perspectives (Table 1) culminating in the formulation of a preliminary structure and content for a test category and its framework.

Table 1 Summary of the first expert interview

| Expert | Main idea |
|---|---|
| Exp 1 | The expert believes that pelvic width and body fat percentage are more important in anthropometric, and aerobic metabolic capacity is more important. he suggested that the technical movement should pay attention to check the correctness of the technique, the stability of the player, and the speed ability. |
| Exp 2 | The expert suggested that in the process of talent identification, more "natural" indicators reflecting endurance event groups should be used, and it is not recommended to choose too many athletic ability indicators with large plastic space. At the same time, the expert believes that the pelvic width and lower limb ratio are more important, and he recommends increasing the ventilation aerobic threshold test. |
| Exp 3 | The expert recommends increasing blood tests for indicators such as testosterone and cortisol. Additional shoulder width testing is also recommended. |
| Exp 4 | The expert suggested that talent identification tests should pay attention to gender differences, as well as focus on athletes' data tracking. Additional thigh and calf circumference tests are recommended. |
| Exp 5 | The expert suggested that psychological testing is very important for the talent identification of racewalkers. And recommended to add blood tests. |
| Exp 6 | The expert recommended removing the sit and reach test and the vital capacity test. And recommended the ventilation aerobic threshold test. |
| Exp 7 | The expert recommends adding IQ tests and lower limb dimension tests |

**3. Delphi method with 21 experts (first round)**

After the first round of expert consultations, this investigation has culminated in a factor structure encompassing 5 primary indices and 34 secondary factors. Then, the first round of Delphi expert consultation was conducted in the early stage of comprehensive test construction. After the first round of the Delphi method, the preliminary comprehensive test for talent identification in Chinese youth racewalkers is shown in Table 2.



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Table 2 The preliminary comprehensive test for talent identification in Chinese youth racewalkers

| Test content | Instrument |
|---|---|
| **1. Anthropometric** | |
| 1. Height (cm) | The standard height and weight scale |
| 2. Weight (kg) | |
| 3. Pelvis Width (cm) | Caliper |
| 4. Thigh Lengths (cm) | |
| 5. Calf Lengths (cm) | |
| 6. Achilles Tendon Length (cm) | |
| 7. Fat Percentage (%) | Inbody human body composition tester |
| **2. Physiological** | |
| Aerobic capacity | Maximum Oxygen Uptake ($VO_2$ max (ml/min/kg) |
| **3. Physical Fitness** | |
| 1. Endurance & speed | 3000m Run (min) |
| 2. Speed & mixed oxidative metabolism | 400m Run (min) |
| 3. Power | Standing Long Jump (m) |
| 4. Flexibility | Sit and Reach (cm) |
| **4. Skill** | 1000m Racewalking (min) |
| **5. Psychological** | Questionnaire Survey |
| 1. Expectation of Winning | (Pezer & Brown, 1980) |
| 2. Motivation to Participate | (Zhang, 2001) |
| 3. Motivation to Avoid | |
| 4. Mental Resilience | (Hu & Gan, 2008) |
| 5. Willpower | (Liang et al., 2005) |

**4. Reliability analysis by retesting**

We used the same test on two occasions to measure consistency (Test-Retest Reliability). The measurements were repeated twice for the 57 athletes, one week before and one week after. In the study, it is generally considered that the R should be greater than 0.80. A range of 0.61 to 0.80 is considered moderate reliability, 0.41 to 0.60 is considered fair reliability, 0.11 to 0.40 is considered low reliability, and less than 0.1 indicates lack of consistency. The correlation of the repeat test is shown in Table 3. As can be seen from Table 5, all R values are greater than 0.8, indicating good reliability in this study. Therefore, the comprehensive test can be accepted for further analysis.

Table 3 Correlation analysis of Test-retest (N=57)



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| Test content | R |
|---|---|
| **1.Anthropometric** | |
| 1. Height (cm) | 0.97** |
| 2. Weight (kg) | 0.98** |
| 3. Pelvis Width (cm) | 0.96** |
| 4. Thigh Lengths (cm) | 0.95** |
| 5. Calf Lengths (cm) | 0.96** |
| 6. Achilles Tendon Length (cm) | 0.92** |
| 7. Fat Percentage (%) | 0.97** |
| **2. Physiological** | |
| Maximum Oxygen Uptake ($VO_2$max) (ml/min/kg) | 0.86** |
| **3. Physical Fitness** | |
| 1. 3000m Run (min) | 0.88** |
| 2. 400m Run (min) | 0.87** |
| 3. Standing Long Jump (m) | 0.92** |
| 4. Sit and Reach (cm) | 0.90** |
| **4. Skill** | |
| 1000m Racewalking (min) | 0.85** |
| **5. Psychological** | |
| 1. Expectation to Win | 0.84** |
| 2. Motivation to Participate | 0.76** |
| 3. Motivation to Avoid | 0.72** |
| 4. Mental Resilience | 0.70** |
| 5. Willpower | 0.81** |

Note: *P＜.05

**5. Implementation of each test among 115 Chinese youth racewalkers**

We conducted tests on a total of 115 participants (68 male and 47 female), selected through snowball sampling. Our study focused on Chinese teenage racewalking athletes aged 15-19.

5.1 Descriptive statistical analysis of each test

The mean and standard deviation (SD) of the test data for a total of 18 factors is shown in Table 4 According to Table 4, the average height of racewalkers is comparable to that of Chinese males and females in the same age group. However, their pelvic width is slightly narrower, which means that a wider pelvis may result in a smaller stride for athletes, thus affecting their racewalking speed. Additionally, racewalkers have slightly longer lower limbs compared to the general population, indicating that they may have certain advantages in leg muscle development. Furthermore, racewalkers have longer Achilles tendons, which may provide them with better elasticity and explosive power, thereby enhancing their flexibility, agility, and flexibility. In terms of weight and body fat percentage, racewalkers are noticeably slimmer than the general population. Additionally, their maximum oxygen consumption is significantly higher than that of the average person, indicating that they possess stronger aerobic exercise capacity. In terms of field tests, racewalkers perform better in the 400-meter run, 3000-meter run, and 1000-meter race walk, and they also have superior standing long jump results.

In terms of psychological data, analysis results show that athletes have a higher level of willpower and mental resilience compared to ordinary people. Based on the data of three indicators: the expectation of winning, motivation to participate, and motivation to avoid, it can be seen that Chinese youth racewalking



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athletes have lower enthusiasm for participation and a stronger avoidance tendency. This should be a matter of concern and attention for coaches. At the same time, we conducted a normality test on each test data for subsequent analysis. Since the number of male athletes is 68 > 50, we tend to use the Kolmogorov-Smirnov (K-S) test, while the number of female athletes is 47 < 50, we tend to use the Shapiro-Wilk (S-W) test. The results show that test items indicate a basic normal distribution.

Table 4 Descriptive statistical analysis of experimental test factors (n=115)

| Test content | Male(n=68) | | Female(n=47) | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| **1. Anthropometric** | | | | |
| Height (cm) | 174.86 | 5.34 | 164.68 | 4.93 |
| Pelvic Width (cm) | 27.35 | 1.60 | 27.23 | 1.64 |
| Thigh Length (cm) | 47.52 | 3.87 | 45.47 | 3.13 |
| Calf Length (cm) | 38.65 | 3.46 | 35.18 | 4.02 |
| Achilles Tendon Length (cm) | 21.63 | 2.53 | 19.27 | 2.75 |
| Body Fat Percentage | 9.64 | 3.63 | 17.32 | 3.68 |
| Weight (kg) | 58.49 | 4.89 | 51.02 | 4.94 |
| **2. Physiological & Physical Fitness** | | | | |
| $VO_2$ max (ml/min/kg) | 60.13 | 4.94 | 52.10 | 6.22 |
| 400m Run (s) | 62.81 | 4.66 | 76.30 | 5.12 |
| 3000m Run (s) | 682.35 | 69.56 | 826.49 | 60.64 |
| Standing Long Jump (m) | 2.31 | 0.15 | 1.95 | 0.16 |
| Sit and Reach (cm) | 13.43 | 7.75 | 15.17 | 7.33 |
| **3. Skill** | | | | |
| 1000m Racewalking (s) | 240.40 | 18.00 | 284.49 | 21.04 |
| **4. Psychological** | | | | |
| Expectation of Winning (score) | 7.32 | 2.42 | 7.57 | 2.62 |
| Motivation to Participate (score) | 9.93 | 1.52 | 9.55 | 1.35 |
| Motivation to Avoid (score) | 8.96 | 2.42 | 8.74 | 2.04 |
| Mental Resilience (score) | 18.93 | 2.48 | 19.31 | 2.72 |
| Willpower (score) | 186.40 | 18.37 | 180.64 | 22.24 |

5.2 Key Test insights from correlation Analysis

The aim purpose of this study is to explore the factors related to excellent racewalking performance and to construct a testing system, providing a reference standard table for talent identification of Chinese youth racewalking athletes. In the process of variable analysis, we take the 10km racewalking performance as the dependent variable and focus on testing and discussing the correlation of each variable with the dependent variable (racewalking performance). Since the test data largely conforms to a normal distribution, we have adopted the Pearson correlation coefficient. The correlation check results between each test data and the athletes' 10km racewalking performance are shown in Table 5, with significance thresholds *p<0.05.

According to Table 5, positive correlations were found in body fat percentage, pelvic width, thigh length, 400m run, 3000m run, 1000m racewalking, and expectation of winning. A negative correlation was found for height, calf length, Achilles tendon length, $VO_2$ max, standing long jump test, sit and reach test, and other psychological measures. At the same time, height, weight, body fat percentage, Achilles tendon length, and motivation to avoid, a total of 5 tests, were not found to be significantly associated with racewalking performance (10km racewalking).



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Table 5 Correlation analysis results between each factor and 10km racewalking performance

| Test content | Male | Female |
|---|---|---|
| | R | R |
| 1. Anthropometric | | |
| 1. Height | -0.01 | -0.09 |
| 2. Body Fat Percentage | 0.11 | -0.20 |
| 3. Weight | -0.02 | 0.14 |
| 4. Pelvic Width | 0.26* | 0.08 |
| 5. Thigh Length | 0.49* | 0.42* |
| 6. Calf Length | -0.22* | -0.28* |
| 7. Achilles Tendon Length | -0.11 | -0.01 |
| 2. Physiological & Physical Fitness | | |
| 1. $VO_2$ max | -0.55* | -0.77* |
| 2. 400m Run | 0.44* | 0.48* |
| 3. 3000m Run | 0.56* | 0.21 |
| 4. Standing Long Jump | 0.01 | -0.23* |
| 5. Sit and Reach | -0.21* | 0.05 |
| 3. Skill | | |
| 1000m Racewalking | 0.82* | 0.78* |
| 4. Psychological | | |
| 1. Willpower | -0.45* | -0.37* |
| 2. Mental Resilience | -0.37* | -0.15 |
| 3. Expectation of Winning | 0.58* | 0.09 |
| 4. Motivation to Participate | -0.20 | -0.31* |
| 5. Motivation to Avoid | 0.25 | 0.24 |

Note: *p < .05

**6. Comprehensive test and the norms results**

6.1 Delphi method with 21 experts (second round)

After the test was implemented, the researcher conducted a second round of Delphi expert evaluations. After the expert screening, the following were removed: height, weight, body fat percentage, Achilles tendon length, and motivation to avoid, a total of 5 tests, and 21 experts confirmed the test items as shown in Table 6.



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Table 6 The results of the second round of Delphi expert evaluation

| Factors | Median | IQR | Result |
|---|---|---|---|
| **1. Anthropometric** | | | |
| 1. Pelvis Width (cm) | 5.00 | 1.00 | Y |
| 2. Thigh Lengths (cm) | 3.00 | 1.00 | Y |
| 3. Calf Lengths (cm) | 4.00 | 1.00 | Y |
| **2. Physiological** | | | |
| 1. Maximum Oxygen Uptake ($VO_2max$) (ml/min/kg) | 5.00 | 1.00 | Y |
| **3.Physical Fitness** | | | |
| 1. Endurance & Speed (3000m Run) | 4.00 | 1.00 | Y |
| 2. Speed & mixed oxidative metabolism (400m Run) | 4.00 | 0.00 | Y |
| 3. Power (Standing Long Jump) | 4.00 | 1.00 | Y |
| 4. Flexibility (Sit and Reach) | 4.00 | 1.00 | Y |
| **4. Skill** | | | |
| 1. 1000m Racewalking | 3.00 | 1.00 | Y |
| **5. Psychological** | | | |
| 1. Expectation of Winning | 4.00 | 1.00 | Y |
| 2. Motivation to Participate | 5.00 | 1.00 | Y |
| 3. Mental Resilience | 4.00 | 1.00 | Y |
| 4. Willpower | 5.00 | 1.00 | Y |

Therefore, the final comprehensive test included content from 5 aspects. Among them, the male test included 11 items, and the female test included 8 items as shown in Table 7).

able 7 The final comprehensive test for talent identification in Chinese youth racewalkers

| Test content | Instrument | Male | Female |
|---|---|---|---|
| **1. Anthropometric** | | | |
| 1. Pelvis Width (cm) | | √ | |
| 2. Thigh Lengths (cm) | Caliper | √ | √ |
| 3. Calf Length | | √ | √ |
| **2. Physiological** | | | |
| Aerobic capacity | Maximum Oxygen Uptake ($VO_2$ max) (ml/min/kg) | √ | √ |
| **3. Physical Fitness** | | | |
| 1. Endurance & speed | 3000m Run (min) | √ | |
| 2. Speed & mixed oxidative metabolism | 400m Run (min) | √ | √ |
| 3. Power | Standing Long Jump (m) | | √ |
| 4. Flexibility | Sit and Reach (cm) | √ | |
| **4. Skill** | 1000m Racewalking (min) | √ | √ |
| **5. Psychological** | Questionnaire Survey | | |
| 1. Expectation of Winning | (Pezer & Brown, 1980) | √ | |
| 2. Motivation to Participate | (Zhang, 2001) | | √ |
| 3. Mental Resilience | (Hu & Gan, 2008) | √ | |
| 4. Willpower | (Liang et al., 2005) | √ | √ |



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6.2. The norm for talent identification in Chinese youth racewalking athletes

In the end, we found that Pelvic Width, Thigh Length, Calf Length, $VO_2$ max, 400m Run, 3000m Run, 1000m Racewalking, Sit and Reach, Willpower, Mental Resilience, and Expectation of Winning, a total of 11 factors are closely related to excellent male racewalkers. On the other hand, Thigh Length, Calf Length, $VO_2$ max, 400m Run, 1000m Racewalking, Standing Long Jump, Willpower, and Motivation to Participate, a total of 8 factors are closely related to excellent female racewalkers. These can be used as the key factors to identify Chinese youth racewalking talents in the future. On this basis, SPSS was used to divide the data of each variable into five groups according to the mean ± SD standard deviation, and the final score table was shown in Table 8 and Table 9.

Among them, the calculation standards for Pelvic Width, Thigh Length, 400m Run, 3000m Run, 1000m Racewalking, and Expectation of Winning are as follows:

Excellent: Score ≤Mean-2sd, Good: Mean-2sd ≤ Score ≤ Mean-1sd, Average: Mean-1sd ≤ Score ≤ Mean+1sd, Poor: Mean+1sd ≤ Score ≤ Mean+2sd, and Very poor: Mean+2sd ≤ Score

In addition, the calculation standards for Calf Length, $VO_2$ max, Standing Long Jump, Sit and Reach, Willpower, Mental Resilience, and Motivation to Participate are as follows:

Excellent: Mean+2sd ≤ Score, Good: Mean+1sd ≤ Score ≤ Mean+2sd, Average: Mean-1sd ≤ Score ≤ Mean+1sd, Poor: Mean-2sd ≤ Score ≤ Mean-1sd, and Very poor: Score ≤Mean-2sd

Table 8 Norm of key tests for talent identification in Chinese male youth racewalkers

| | | Excellent | Good | Average | Poor | Very poor |
|---|---|---|---|---|---|---|
| 1 | Pelvic Width (cm) | ≤24.15 | 24.16-25.75 | 25.76-28.94 | 28.95-30.54 | ≥30.55 |
| 2 | Thigh Length (cm) | ≤39.79 | 39.80-43.66 | 43.67-51.39 | 51.40-55.26 | ≥55.27 |
| 3 | Calf Lengths (cm) | ≥45.56 | 42.11-45.55 | 35.19-42.10 | 31.73-35.18 | ≤31.72 |
| 4 | $VO_2$ max (ml/min/kg) | ≥70.01 | 65.07-70.00 | 55.19-65.06 | 50.25-55.18 | ≤50.24 |
| 5 | 400m Run (mm: ss) | ≤00:53 | 00:54-00:57 | 00:58-01:06 | 01:07-01:11 | ≥01:12 |
| 6 | 3000m Run (mm:ss) | ≤09:02 | 09:03-10:13 | 10:14-12:31 | 12:32-13:40 | ≥13:41 |
| 7 | 1000m Racewalking (mm: ss) | ≤03:24 | 03:25-03:42 | 03:43-04:18 | 04:19-04:36 | ≥04:37 |
| 8 | Sit and Reach (cm) | ≥28.94 | 21.18-28.93 | 10.12-21.17 | 5.68-10.11 | ≤5.67 |
| 9 | Willpower (score) | ≥223 | 205-222 | 168-204 | 150-167 | ≤149 |
| 10 | Psychological Resilience (score) | ≥24 | 21-23 | 16-20 | 14-15 | ≤13 |
| 11 | Expectancy of Winning (score) | ≤2 | 3-4 | 5-8 | 9-11 | ≥12 |

Table 9 Norm of key tests for talent identification in Chinese female youth racewalkers

| | | Excellent | Good | Average | Poor | Very poor |
|---|---|---|---|---|---|---|
| 1 | Thigh Length (cm) | ≤39.22 | 39.21-42.35 | 42.36-48.59 | 48.60-51.73 | ≥51.74 |
| 2 | Calf Lengths (cm) | ≥43.22 | 39.21-43.21 | 31.18-39.20 | 27.16-31.17 | ≤27.15 |
| 3 | $VO_2$ max (ml/min/kg) | ≥64.56 | 58.33-64.55 | 45.88-58.32 | 39.66-45.87 | ≤39.65 |
| 4 | 400m Run (mm: ss) | ≤01:06 | 01:07-01:11 | 01:12:01:21 | 01:22-01:26 | ≥01:27 |
| 5 | 1000m Racewalking (mm: ss) | ≤04:02 | 04:03-04:23 | 04:24-05:05 | 05:06-05:26 | ≥05:27 |
| 6 | Standing Long Jump(m) | ≥2.27 | 2.12-2.26 | 1.80-2.11 | 1.64-1.79 | ≤1.63 |
| 7 | Willpower (score) | ≥226 | 204-225 | 159-203 | 137-158 | ≤136 |
| 8 | Motivation to Participate (score) | ≥12 | 9-11 | 8-10 | 7-8 | ≤6 |

## Conclusion

This study developed a comprehensive test for talent identification in Chinese youth racewalker athletes through a series of rigorous procedures and methods. The final comprehensive test for talent identification in Chinese youth racewalking athletes encompasses five aspects: Anthropometric, Physiological, Physical Fitness, Skill, and Psychology. Among them, there are 11 tests for male talent identification namely (1) Pelvic Width; (2) Thigh Length; (3) Calf Length; (4) $VO_2$ max; (5) 400m Run;



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(6) 3000m Run; (7) 1000m Racewalking; (8) Sit and Reach; (9) Willpower; (10) Mental Resilience; and (11) Expectation of Winning, and 8 tests for female talent identification namely (1) Thigh Length; (2) Calf Lengths; (3) $VO_2$ max; (4) 400m Run; (5) 1000m Racewalking; (6) Standing Long Jump; (7) Willpower; and (8) Motivation to Participate.

**Discussion**

The comprehensive test and norms constructed in this study indicate that in the future, the criteria for male and female athletes should differ slightly in the process of identifying outstanding Chinese youth racewalking talents. Among them, men should focus on a narrower pelvis, shorter thighs, longer calves, better maximal oxygen uptake, and better performance in 400-meter running, 3,000-meter running, 1,000-meter walking, and sit-and-reach tests. Psychological aspects should pay attention to mental resilience, high willpower, and expectation of winning. For female athletes, shorter thighs, longer calves, high maximal oxygen uptake, and better performance in 400-meter running, and 1,000-meter walking and standing long jump tests are also worth focusing on. Moreover, the psychological part should pay attention to athletes with high motivation to participate and strong willpower. The results of the comprehensive test and norms will provide an important reference for China's future selection of outstanding youth racewalking athletes.

Firstly, from the perspective of anthropometry, the body structure of male athletes should have a narrow pelvis, shorter thighs, and longer lower legs. A narrow pelvis and long lower legs can provide a more stable and efficient gait, while shorter thighs can reduce energy loss during exercise. These body characteristics help improve the efficiency of racewalking. For female athletes, although the width of the pelvis may be larger than that of male athletes, shorter thighs and longer lower legs are also body features worth paying attention to. There is plenty of research on the correlation between body measurement traits and athletic performance, and for different events, research also shows the association between body structure and sports performance. This is consistence with Gomez-Ezeiza et al. (2018) the lower body fat percentage is beneficial to the performance of strength and endurance, which is an important characteristic for achieving excellent competitive results.

Secondly, in terms of physiology, maximal oxygen uptake is an important indicator of an athlete's aerobic exercise capacity. Whether male or female athletes, a higher maximal oxygen uptake may have a positive impact on racewalking performance. This is consistence with Sjodin & Svedenhag (1985) Maximum oxygen uptake ($VO_2$ max) is an important indicator for evaluating aerobic exercise capacity and is significantly positively correlated with racewalking performance.

In terms of skills and physical fitness, the performances in 400m run, 3000m run, and 1000m racewalking are important indicators to measure the athlete's racewalking skills and physical fitness. The 3000m run and 1000m racewalking test the athlete's medium and long-distance endurance. The results of these tests can reflect the athlete's speed, endurance, and racewalking skills, and have important reference value for selecting racewalking athletes. This is consistence with Hu & Wang (2010) Specialized endurance is one of the most important abilities of racewalking athletes, which can be evaluated by longer walking or running times.

In the psychological aspect, racewalking athletes need to possess tenacious mental qualities and strong willpower. The process of competition is full of challenges and difficulties, athletes need to have a high level of participation willingness and devote themselves to training and competition. Therefore, racewalkers should have superhuman patience to endure extreme physical and mental fatigue, only with strong willpower can athletes meet the needs of training and competition (Zhou, 2016).



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**Recommendation**

1. Coaches and researchers must pay heed to the physical attributes of the athletes during the testing phase.
2. The talent selection system should be fortified to establish a robust foundation for project development.
3. The implementation of scientific training concepts and methods is crucial for the enhancement of comprehensive competitive strength. The coaching level should be improved, with the integration of advanced training methods and personalized teaching emphasized.
4. Training and competition rhythms should be optimized, with dynamic adjustment of training plans and intelligence collection given due attention.

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