

## CONSTRUCTION OF THE SKILL RELATED PHYSICAL FITNESS EVALUATION INDEX SYSTEM OF CHINESE YOUNG MALE TENNIS PLAYERS

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### Abstract

The skill-related physical fitness evaluation index system is an important reference basis for evaluating the competitive level of tennis players. At present, there are few studies on the skill-related physical fitness evaluation index system of Chinese young male tennis players. Based on the characteristics of tennis events and the sensitive period of the development of young tennis players skill-related physical fitness variables, this study uses literature methods, Delphi method and other research methods to construct an evaluation index system for Chinese young male tennis players skills related physical fitness. The results show that: Chinese young male tennis players skill-related physical fitness includes six first-level indicators including speed, strength, endurance, agility, flexibility, and power, 11 second-level indicators such as aerobic endurance, anaerobic endurance, upper body power, and lower body power, etc. 16 third-level indicators such as the hexagon test, beep test, sit and reach, etc.

**Keywords:** Young tennis player, skill-related physical fitness, Evaluation index system

### Introduction

Tennis is a popular competitive sport attracting millions of players and fans worldwide (Gomes et al., 2013). Professional tennis players travel and compete extensively all year round, and there are many different opportunities for all level players to compete in any given week of the year. The game of tennis has evolved from the wooden-racket era of long, crafty points based on style and finesse, to the current fast-paced, explosive sport based on power, strength and speed (Kovacs, 2007). A tennis match is an explosive, multi-directional, brisk creative and skilful game. Nowadays, tennis players becoming faster, powerful and aggressive, but because of novel technologies and materials in tennis racquet and ball design, this sport

requires better physical and skill-related performance, this is because success in tennis is greatly affected by the technique a player uses and skill-related physical fitness plays an integral role in stroke production., in order to be competitive and successful, tennis players will need a mixture of speed, agility, power, strength, and moderate to high aerobic capacity and other skill-related physical performance (Hornery, Farrow, Mujika, & Young, 2007). The term “young” refers to the period of time between childhood and adulthood and includes girls aged 12-18 years and boys aged 14-18 years (Tanner stages 3 and 4 of sexual maturation) (Behm, Faigenbaum, Falk, & Klentrou, 2008). This age stage is the most important stage in the growth and development of the human body. At this stage, grasping the sensitive period of the development of skill-related physical fitness variables for targeted training is essential for athletes' physical fitness training. In recent years, Chinese sports experts and scholars have made some research achievements on physical fitness training of tennis players, but most of them have a focus on the practice of physical fitness training, the physical fitness characteristics of tennis players, the importance of physical fitness in tennis, sports injuries and so on (Ji-qiang, 2004; Luan, L. X., & Xu, 2005; Xiaoyang, W., & Haitao, 2013; Zhen, X. X., & Li, 2010). However, there are few studies on the physical fitness evaluation system skill-related physical fitness of tennis players, especially the research on skill-related physical fitness evaluation index system of Chinese young male tennis players. Therefore, through in-depth cognition of the characteristics of tennis sports, combined with the development law of players skill-related physical fitness variables, a simple and practical skill-related physical fitness evaluation index system was constructed on this basis providing reference standards and basis for the evaluation of Chinese young male tennis players skill-related physical fitness.

## **1. Research objects and methods**

### *1.1 Research objects*

This study takes Chinese young male tennis players skill-related physical fitness evaluation indicators as the research objects and takes experts, coaches and referees in the field of Chinese tennis as the investigation objects.

### *1.2 Research methods*

The research in this study includes both qualitative and quantitative research. In the research results, the collection of Chinese young male tennis players skill-related physical fitness evaluation indicators belongs to the category of qualitative research, and the selection of Chinese young male tennis players skill-related physical fitness evaluation indicators belongs to the category of quantitative research. The specific research methods are as follows:

#### *1.2.1 Literature method*

This research uses tennis, young tennis players, skill-related physical fitness, assessment, evaluate, etc. as keywords, and search through CNKI (China largest journal database), EBSCO sports science database, Sport Discus database, Web of Science database, Scopus database, and about young tennis players and skill-related

physical fitness literature, based on extensive reading and collating literature, focused on reading, summarizing and collating materials related to physical fitness and construction of the skill-related physical fitness of young tennis players. In addition, through the International Tennis Federation, State Physical Culture Administration, Chinese Tennis Association and other official websites, a wide range of domestic and foreign young tennis competition information and basic information about athletes have been collected, providing a certain theoretical basis for writing this study.

### 1.2.2 Delphi method

This study draws up the original indicators for the skill-related physical fitness evaluation of young male tennis players after consulting a large number of relevant literature. On this basis to design “Chinese young male tennis players skill related to physical fitness evaluation index selection expert questionnaire” (5point Likert scale). After the questionnaire design is completed, it will be distributed to young tennis coaches with many years of teaching and training experience (including coaches of national teams, tennis teams in Zhejiang Province, Henan Province, Fujian Province, Shanghai and other provinces and cities), tennis teaching in sports colleges and national-level tennis referees, they scored the importance of the original indicators skill-related physical fitness of young male tennis players. A total of two rounds of expert questionnaire surveys were conducted. The second questionnaire screening result was the final result. According to the scoring result, an index above the “important” level (average score  $\geq 4$  points) is used as the evaluation index for the skill-related physical fitness variables of young male tennis players, and the average score of the evaluation index is 4 (important) or above as the selection criteria for the evaluation index, delete or merge the evaluation indicators that are not very useful, and optimize the more complex evaluation indicators based on expert opinions, and select more representative skill-related physical fitness evaluation indicators to evaluate the skill-related physical fitness of young male tennis players.

**Table 1** Expert Basic Information Form (n=16)

Position	National level coaches	Senior coaches	Prof	Assoc. Prof	National-level tennis referees
Number	4	3	3	4	2

#### (1) Questionnaire validity

The evaluation index screening questionnaire (the second round) and the validity test questionnaire were distributed to 16 experts for investigation, and the validity of the questionnaire was tested.

**Table 2** Validity Test Form (n=16)

Evaluation	Very reasonable	More reasonable	General	Unreasonable	Very unreasonable
Frequency	5	7	4	0	0
percentage	31.25%	43.75%	25%	0	0

The survey results show that the expert questionnaire on the “Expert Questionnaire for Screening Chinese Young male Tennis Players Skill Related Physical Fitness Evaluation Index” is very reasonable, accounting for 31.25%, more reasonably accounting for 43.75%, and general accounting for 25%. There are no unreasonable or very unreasonable opinions, indicating that the questionnaire has good validity.

(2) *Questionnaire reliability*

The reliability test of the questionnaire adopts a small-scale “test-retest” method and the data measured twice are processed. The correlation coefficient between 0 and 1 indicates that the reliability of the questionnaire meets the requirements. The same questionnaire was distributed to the five experts again, analyze the data of the returned questionnaire, and compare it with the results of the first questionnaire. The correlation coefficient of the two questionnaires was calculated by  $r=0.89$ ,  $P<0.01$ , indicating that the questionnaire has good reliability.

(3) *Issuance and collection of questionnaires*

**Table 3** Questionnaires issuance and collection form

Questionnaire round	Issue questionnaires	Collect questionnaires	Recovery rate	Valid questionnaires	Effective rate
First round	16	16	100%	16	100%
Second round	16	16	100%	16	100%

**2. Principles of constructing skill-related physical fitness evaluation index system for Chinese young male tennis players**

Young male tennis players skill-related physical fitness is an aggregate of multiple variables, mutual promotion and mutual restriction between the variables, at the same time, the importance of each variable in the skill-related physical fitness of young tennis players is different. The change of a certain variable affects the skill-related physical fitness level changes. When selecting the skill-related physical fitness evaluation indicators for young male tennis players, the young male tennis players skill-related physical fitness evaluation index selection actually should choose which index, which measures can reflect more young male tennis players skill-related physical fitness level, in addition, to conform to the principle of statistics, should also follow the following principles:

*2.1 Scientific principle*

Scientific principles are the prerequisite for research (Ben-li, 2006). In this study, the screening of skill-related physical fitness evaluation indicators for young male tennis players strictly follows the scientific principle. First, the screening of skill-related physical fitness evaluation indicators is scientific, that is, the selection of practical test indicators verified by experiments from relevant studies; Secondly, in the process of selecting the indicators of skill-related physical fitness, we should respect the scientific principle, including the statistical data process and the methods used in the process of index selection should be carried out strictly in accordance with the scientific principles. Third, the scientific principle also reflected in the process of evaluation index selection skill-related physical fitness strictly follow tennis movement project characteristic, based on the young male tennis players body growth and development rules, genetic characteristics and skill-related physical fitness variables such as the development of sensitive period for skills related fitness evaluation index screening.

*2.2 Systemic principle*

The evaluation index system is a huge and complex system, which should abide by systematic principles. In the preliminary screening stage of the skill-related physical fitness evaluation indicators of young male tennis players, some evaluation indicators should be screened, and there is a certain logical relationship between these indicators, and they are mutually restricted. The systematic evaluation indicators can not only reflect the characteristics and status of the skill-related physical fitness variables of young male tennis players, but also reflect the internal relationship between the indicators, and the indicators cannot contradict each other. A complete set of evaluation index system needs to be hierarchical in order to reflect the system.

*2.3 Operability and practicality principle*

The operability and practicability of the skill-related physical fitness evaluation indexes of young male tennis players are the key factors considered in the evaluation index selection process. When collecting skill-related physical fitness evaluation indicators, not only should the existing research data be used, but also evaluation

indicators that can be obtained through statistical collation, sampling surveys or field tests should be selected. Those unmeasurable indicators should be deleted, or those that are theoretically measurable but not easy to measure in actual surveys. Under the premise of satisfying the operability and practicality principle, delete or merge the ineffective evaluation indicators, and combining with expert advice on complex evaluation index to optimize processing, select more representative evaluation index to evaluate the level of young tennis player skill-related physical fitness.

### **3. The theoretical basis for constructing the skill-related physical fitness evaluation index system of young male tennis players**

#### *3.1 The characteristics of tennis*

Tennis match play is characterized by intermittent exercise, alternating short (4-10 seconds) bouts of high-intensity exercise and short (10-20 seconds) recovery bouts interrupted by several resting periods of longer duration (60-90 seconds)(Fernandez, Mendez-Villanueva, & Pluim, 2006; Julian, Kristiyanto, & Purnama, 2019; Kovacs, 2007). The duration of a tennis event is often greater than an hour and in some cases lasts for 5 hours (e.g., Australian Open 2009 men s final: 4 hours 23 minutes) with a typical average match time of 1.5 hours (Kovacs, 2007a), in which effective playing time (percentage of the total time of play in a game) amounts to approximately 20 to 30% on clay courts and to 10 to 15% on hard court surfaces (Fernandez et al., 2006; Kovacs, 2007; Morgans, Jordan, Baeyens, & Franciosa, 1987). During this time, a tennis player runs an average of 3m per shot and a total of 8 to 15 m in the pursuit of one point, completing from 1,300 to 3,600 m/hour of play, depending on the player s level (amateur or advanced) and court surface (slow or fast) (Deutsch, E., Deutsch, S. L., & Douglas, 1998; Fernandez-Fernandez, J., Sanz-Rivas, D., Sanchez-Muñoz, C., Pluim, B. M., Tiemessen, I., & Mendez-Villanueva, 2012; Murias, J. M., Lanatta, D., Arcuri, C. R., & Laino, 2007). Players average 2.5 to 3 strokes per rally, and approximately 80% of all strokes are played within less than 2.5 m, with the player in a standing position (Reid & Schneiker, 2008). Approximately 10% of all strokes are made with 2.5 to 4.5 m of movement with primarily a sliding-type movement pattern, and fewer than 5% of all strokes are made with greater than 4.5 m of movement and a running-type movement pattern (distance recorded immediately after each stroke and needed to reach the stroke position) (Reid & Schneiker, 2008). Therefore, in order to be competitive and successful, tennis players will need a mixture of speed, agility, power, and moderate to high aerobic capacity and other skill-related physical performance. The indicator system should mainly focus on strength, speed, endurance, etc. Core qualities are constructed. The index system should mainly focus on core qualities such as strength, speed and endurance.

#### *3.2 The sensitive period of development of young tennis players skill-related physical fitness variables*

China's sports department has not yet established a clear age division between "young", and different organizations or institutions have quite different age divisions. Young includes childhood and adolescence; childhood refers to boys and girls who have not yet developed secondary sex characteristics (approximately up to age 11 in girls and 13 in boys; Tanner stages 1 and 2 of sexual maturation). This period of development is often referred to as pre-adolescence. The term "adolescence" refers to the period of time between childhood and adulthood and includes girls aged 12-18 years and boys aged 14-18 years (Tanner stages 3 and 4 of sexual maturation) (Behm et al., 2008). Mo Xiao-chun in thinking about "young" age define research thinks, young in narrow sense refers to a child to an adult excessive phase, divided into the juvenile period (12-14) and the early youth (15-18 years old), and generally divided into childhood (6-11), narrow sense of adolescent stage (12-18), and the youth stage three age (19-40 years old) (Mo, 2009). Through the above research, it can be found that there is still a lot of controversy about the age limit of young. In this study, the age range of young male tennis players is between 14 and 18 years old, based on the setting of young tennis events on the websites of Tennis Administrative Center of the General Administration of Sport of China and Tennis Association of China. The growth rate of skill-related physical fitness variables is also different at different age stages. Even at the same age, different skill-related physical fitness variables have different sensitive stages of development, for example, 1) Endurance. The sensitive period of endurance is relatively late. The initial training is only available for girls at the age of 12-14 and boys at the age of 14-16. High-level training for aerobic endurance can only be carried out at the age of 16-18. For high-level training for anaerobic endurance, girls should be 16-18 years old and boys 18-20 years old; 2) Strength and power. According to the law of growth and development, the sensitive period of muscle development is 8-9 years

old. During this period, muscle development is relatively fast. By the age of 15, the small muscle groups of the body also begin to develop rapidly. The sensitive period of trunk strength development is 15-18 years old. During this period, trunk strength increases rapidly. Therefore, young children are suitable for strength training with their own weight before the age of 10, and some equipment can be added slightly at the age of 12-13. At the age of 15-18, the growth and development of the body are almost over. This stage is muscle strength. And the sensitive period of volume growth can increase some resistance and weight training; 3) speed. According to research, girls are 6-8 years old and 11-13 years old, these two stages are the sensitive period of speed development, while the sensitive period of boy speed development is 7-9 years old and 13-16 years old; 4) Flexibility. In the process of exercise, in order to reach a high level, flexibility training is essential. Flexibility training is generally carried out in the early stages of training (5-12 years old), that is, when the age is relatively young. Young is the accelerated period of physical development. The speed of physical development is fast and large. At the end of sexual maturity, the growth rate of skill-related physical fitness variables begins to slow down; 5) Agility. The agility of the young nervous system is the highest, and the period of strongest plasticity is mainly concentrated in the age of 10-15. This stage has the best effect on improving agility. After adulthood, a certain level of agility can still be continued between the ages of 18-25, but the agility gradually decreases with age (Guangxun, 2001; Jin-yuan, Z., Jing, M. I., & Shi-qiang, 2015; Li Lei, 2017; Zhang, Z. H., Zhou, J. M., & Huang, 2009; Zhou, G., Ji, L., & Yin, 2016). At different age stages, the sensitive period of the development of skill-related physical fitness variables is different, so the focus of the selection of skill-related physical fitness evaluation indicators of young male tennis players in this age group is different.

#### **4. The screening process of skill-related physical fitness evaluation indicators of Chinese young male tennis players**

The evaluation index is the data reaction element that the makers make specific and systematic judgments for the evaluation object according to the evaluation purpose (Dwyer, 1996). The establishment of a young tennis player skill-related physical fitness evaluation index system should have a certain scientific basis, and the selection of evaluation indexes should be combined with the actual situation of the research object. In 2006, Sun Qing-zu in the "Sports Measurement and Evaluation" that the selection of sports indexes should be carried out in accordance with the corresponding steps. First, the selection of preselected indexes should be based on a certain logical theoretical knowledge; Second, the selection of preselected indexes should be carried out. The integration of expert opinions; Third, the second round of index screening should be carried out based on the results of pre-selected index screening (Qing-zu, 2006). Based on the relevant theories of evaluation index screening, combined with the characteristics of tennis sports and the development of the sensitive period theory of skill-related physical fitness variables, this research finally screened the young male tennis players skill-related physical fitness evaluation indexes.

##### *4.1 Collection of pre-selected evaluation indicators*

In the long-term training process of tennis players, through systematic physical and skill training, the shaping of their bodies and functions presents specialized characteristics. Skill related physical fitness refers to the various abilities shown by the human body when completing actions, usually referring to speed, strength, endurance, agility and flexibility. Skill related physical fitness refers to the general term for the variables needed to enable athletes to adapt to the high-load training or competition of modern tennis and to enable athletes to better master complex tennis techniques and difficult movements. The skill-related physical fitness of young male tennis players in this study is based on the theory of "Sports Training", including strength (upper body strength, trunk strength, lower body strength), endurance (aerobic endurance and anaerobic endurance), agility, flexibility, and power (upper body power and lower body power), speed (movement speed and moving speed) (Mai-jiu, 2000). From this perspective, complete the collection of pre-selected evaluation indicators for young male tennis players skills-related physical fitness. The main sources of the pre-selected evaluation indicators in this study as follows: Firstly, consult relevant books and literature on tennis sports; Secondly, from the literature or books of other network-related sports (badminton, table tennis, volleyball, etc.), we collected as many evaluation indexes of skill-related physical fitness as possible and determined six first-level indexes, 11 second-level indexes and 69 third-level indexes in total.

**Table 4** Evaluation indicators of skill-related physical fitness preselection of young male tennis players

No.	Indexes	No.	Indexes
1	2400m run	2	12min run
3	Beep test	4	Step test
5	1500m run	6	3000m run
7	1000m run	8	Tennis-specific agility endurance test
9	400m run	10	800m run
11	50m*8 round trip	12	10m*8 round trip
13	Grip strength test	14	Push up bars
15	Pull-up	16	Bench press (Maximum strength)
17	Deadlift	18	Standing barbell press
19	1min push up	20	Five step frog leaping
21	Wall squat test	22	Weight-bearing squat
23	1min sit up	24	1min Pointed Angle with Hang
25	1min Prone and back up	26	Back touch test
27	1min "V-up" test	28	Over medicine ball throw test
29	Sidearm medicine ball throw test (right and left)	30	Speed of service
31	Tennis ball throw test	32	30s barbell flat push
33	10s clap push-ups	34	Standing long jump/hop
35	Vertical jump test	36	Single leg vertical jump test
37	3-step approach vertical jump test	38	Standing single leg long jump test
39	10s fast high leg lift	40	20m sprint
41	5m sprint	42	10m sprint
43	30m sprint	44	Singles sideline sliding step
45	20m*5 round trip	46	60m sprint
47	100m sprint	48	36m sprint
49	45s number of service swings	50	45s number of backhand swings
51	45s number of forehand swings	52	Center split
53	"米" type run	54	Sit and reach
55	Stand and reach	56	Prone upper body back
57	"十" type change direction run	58	Both leg hexagon jump test
59	Shuttle run	60	1min single swing rope skipping
61	30s double swing rope skipping	62	Left leg hexagon jump test
63	Right leg hexagon jump test	64	Planned agility test
65	Turn left and sprints forward	66	Turn right and sprints forward
67	The left line back sprint	68	The right line back sprint
69	front split	70	

#### 4.2 Selection and modification of evaluation indicators

The selection of the effective evaluation index of young tennis players skill-related physical fitness level is an important part of constructing the skill-related physical fitness evaluation system of young tennis players (Gang-qiang, 2006). In the process of athlete's skill-related physical fitness assessment, the more evaluation indicators, the more comprehensive the assessment of the athlete's skill-related physical fitness level, but too many evaluation indicators will bring a lot of inconvenience to the research (Xiu-lan, 2019). Therefore, in the process of the evaluation index selection in this study, two expert questionnaires were used to screen the pre-selected evaluation indexes by using the 5-level Likert scale, 1 to 5 represent higher and higher importance (1=very unimportant; 2=Not important; 3=general; 4=important; 5=very important), calculate the average score of each preselected index according to the expert evaluation results, and use the average index

of 4 points (important) or above as the selection criteria for the evaluation index (Liu, W. T., Gu, H., & Li, 2011), delete or merge evaluation indicators that have little effect, and optimize the more complex evaluation indicators based on expert opinions, and select more representative evaluation indicators to evaluate the level of skill-related physical fitness of young male tennis players.

4.2.1 The first round of index screening and analysis

The pre-selected evaluation indicators are made into the first round of expert questionnaires, and the questionnaires are distributed to relevant experts. Experts will score each evaluation indicator according to the importance level indicated in the questionnaire. Through statistical analysis of the results of the first round of expert questionnaires, there are 39 test indicators that have an average score of 4 points or more (including 4 points). They are 20m sprint, 10m sprint, 30m sprint, 60m sprint, Singles sideline sliding step, 20m\*8 round trip, 45s number of forehand swings, 45s number of backhand swings, 45s number of service swings, Grip strength test, Pull-up, 1min push-up, 1min Prone and back up, 1min sit up, 1min “V-up” test, Wall squat test, Weight-bearing squat, Beep test, Step test, 400m run, 50m\*8 round trip, 10m\*10 round trip, Tennis-specific agility endurance test, Stand and reach, Sit and reach, Back touch test, 1min single swing rope skipping, 30s double swing rope skipping, Planned agility test, Turn left and sprints forward, The left line back sprints, The right line back sprint, Over medicine ball throw test, Sidearm medicine ball throw test (right and left), speed of service, Tennis ball throw test, Standing long jump/hop, Vertical splits test, 3-step approach vertical jump test.

**Table 5** The first round of expert questionnaire survey on the importance of skill-related physical fitness evaluation indicators (n = 16)

First-level indexes	Second-level indexes	Third-level indexes	Mean	
Speed	Moving speed	20m sprint	4.5	
		5m sprint	3.5	
		10m sprint	4.25	
		30m sprint	4.75	
		60m sprint	4.375	
		100m sprint	3.13	
		Singles sideline sliding step	4.38	
	Movement speed	20m*8 round trip	4.44	
		36m sprint	2.94	
		45s number of forehand swings	4.56	
		45s number of backhand swings	4.56	
		“米”type run	3.88	
		45s number of service swings	4.38	
		Strength	Upper body strength	Grip strength test
Push up bars	3.13			
Pull-up	4.125			
Bench press (Maximum strength)	2.88			
deadlift	2.31			
1min push up	4.25			
Standing barbell press	2.75			
Trunk strength	1min pointed angle with hang		3.13	
	1min Prone and back up		4.25	
	1min sit up		4.63	
	1min “V-up” test		4.19	
	Lower strength		Five step frog leaping	2.75
			Wall squat test	4.38
			Weight-bearing squat	4.06



		2400m run	3.69		
		12min run	2.81		
	Aerobic endurance	Beep test	4.38		
		Step test	4.06		
		1500m run	3.44		
Endurance		3000m run	2.94		
		1000m run	3.69		
		400m run	4.13		
	Anaerobic endurance	800m run	3.81		
		50m*8 round trip	4.44		
		10m*10 round trip	4.44		
		Tennis-specific agility endurance test	4.56		
			Front split	3.75	
		Center split	3.69		
Flexibility	Flexibility	Prone upper body back	3.13		
		Stand and reach	4.38		
		Sit and reach	4.62		
		Back touch test	4.06		
				“十”change direction run	2.75
		Both leg hexagon jump test	3.69		
		Shuttle run	3.81		
Agility	Agility	1min single swing rope skipping	4.25		
		30s double swing rope skipping	4.25		
		Left leg hexagon jump test	3.13		
		Right leg hexagon jump test	3.13		
		Planned agility test	4.31		
		Turn left and sprints forward	4.31		
		Turn right and sprints forward	3.75		
		The left line back sprints	4.25		
		The right line back sprint	4.25		
				Over medicine ball throw test	4.31
				Sidarm medicine ball throw test (right and left)	4.44
	Upper body power	Speed of service	4.19		
		Tennis ball throw test	4.31		
		30s barbell flat push	3.12		
		10s clap push-ups	3.18		
Power		Standing long jump/hop	4.56		
		Vertical splits test	4.5		
	Lower body power	Single leg vertical jump test	3.81		
		3-step approach vertical jump test	4.13		
		Standing single leg long jump test	3.88		
		10s fast high leg lift	3.44		

In order to select more representative evaluation indicators, the 39 evaluation indicators selected in the first round of the expert questionnaire were screened and optimized. 1) During the questionnaire survey, experts suggested that the characteristics of tennis can be combined with the moving speed test indicators, change 20m sprint, 10m sprint, 30m sprint, 60m sprint to Singles sideline round trip\*4 as the evaluation index of the second round of expert questionnaire; 2) In the anaerobic endurance test, the 50m\*8 round trip and 10m\*10 round trip were changed to doubles sideline round trip\*5; 3) In the agility index, turn left and sprints forward, turn right and sprints forward, the left line back sprints and the right line back sprint are the most commonly

used test methods in tennis. The direction of movement is different. We only need to select two opposite ones, so these four the indicators are merged into a turn left and sprints forward and the right line back sprint. The evaluation indicators selected by the first round of experts are made into the second round of expert questionnaires, and the second round of expert questionnaire data is summarized and analyzed to obtain the second round of expert questionnaire skill-related physical fitness evaluation indicators. (See the table below for details)

**Table 6** The second round of expert questionnaire on the importance of skill-related Physical fitness evaluation indicators (n=16)

First-level indexes	Second-level indexes	Third-level indexes	Mean	
Speed	Moving speed	Singles sideline round trip*4	4.69	
		Singles sideline sliding step	3.94	
		20m*8 round trip	3.88	
	Movement speed	45s number of forehand swings	4.44	
		45s number of backhand swings	4.5	
		45s number of service swings	3.69	
	Strength	Upper body strength	Grip strength test	4.69
			Pull-up	3.56
			1min push up	4.56
		Trunk strength	1min Prone and back up	3.81
1min sit up			4.75	
1min “V-up” test			3.56	
Lower body strength		Aerobic endurance	Wall squat test	4.63
			Weight-bearing squat	3.75
		Anaerobic endurance	Beep test	4.44
			Step test	3.13
Endurance	Flexibility	400m run	3.06	
		Singles sideline round trip*5	3.44	
	Agility	Tennis-specific agility endurance test	4.44	
		Stand and reach	3.88	
		Sit and reach	4.38	
Flexibility	Agility	Back touch test	3.25	
		1min single swing rope skipping	3.94	
	Power	30s double swing rope skipping	4.13	
		Planned agility test	4.63	
		Turn left and sprints forward	3.81	
Agility	Upper body power	Turn right and sprints forward	3.81	
		Over medicine ball throw test	4.44	
	Lower body power	Sidearm medicine ball throw test (right and left)	4.56	
		speed of service	3.31	
		Tennis ball throw test	3.81	
Power	Lower body power	Standing long jump/hop	4.63	
		Vertical splits test	4.56	
		3-step approach vertical jump test	3.81	

Through the data analysis of the second round of expert questionnaires, the evaluation indicators with the importance of skill-related physical fitness evaluation indicators above 4 points are screened out, and those with the importance of skill-related physical fitness evaluation indicators below 4 points are deleted, and most of them are second-level indicators only correspond to 1-2 three-level indicators, and most of the

three-level indicators have been screened out. A total of 11 second-level indicators (movement speed, moving speed, upper body strength, trunk strength, lower body strength, aerobic endurance, anaerobic endurance, flexibility, agility, upper body power, lower body power); 16 three-level indicators ( Singles sideline round trip\*4, 45s number of backhand swings, 45s number of forehand swings, grip strength test, 1min push-up, 1min sit up, wall squat test, beep test, tennis-specific agility endurance test, sit and reach, 30s double swing rope skipping, planned agility test, over medicine ball throw test, sidearm medicine ball throw test(right and left), standing long jump/hop, vertical splits test.)(See the table below for details)

**Table 7** Screening results of skill-related physical fitness evaluation indexes for young male tennis players

First-level indexes	Second-level indexes	Third-level indexes
Speed	Moving speed	Singles sideline round trip*4
	Movement speed	45s number of backhand swings 45s number of forehand swings
Strength	Upper body strength	Grip strength test 1min push up
	Trunk strength	1min sit up
	Lower body strength	Wall squat test
Endurance	Aerobic endurance	Beep test
	Anaerobic endurance	Tennis-specific agility endurance test
Flexibility	Flexibility	Sit and reach
Agility	Agility	30s double swing rope skipping
Power	Upper body power	Planned agility test
		Over medicine ball throw test
		Sidearm medicine ball throw test (right and left)
	Lower body power	Standing long jump/hop
		Vertical splits test

### 5.0 Conclusion

This research is based on previous studies, combined with the sensitive period of the development of tennis sports event characteristics and skill-related physical fitness variables, and conducted an in-depth analysis and discussion on the skill-related physical fitness characteristics of tennis players. Through the process of preliminary screening, coaches and experts argumentative screening, statistical screening of test indicators, finally determined the Chinese young male tennis player skills related physical fitness evaluation index system. Chinese young male tennis players skill-related physical fitness evaluation index system includes six first-level indicators including speed, strength, endurance, agility, flexibility, and power, and 11 second-level indicators including aerobic endurance, anaerobic endurance, upper body power, and lower body power—16 three-level indicators such as 1min sit-ups, Beep test, etc.

### Research limitations

It is an exploratory work to construct a skill-related physical fitness evaluation system for young male tennis players. Although researchers adhere to a scientific and rigorous attitude and follow scientific research procedures, there are still some research deficiencies and limitations: 1) Because the evaluation index system involves content extensive, the selected experts may have cognitive limitations. For example, due to differences in professional background, experts have different opinions on the selection of certain indicators; 2) With the development of tennis, it affects the skill-related physical fitness of young male tennis players variable factors are complex and constantly changing. Even if the opinions of many experts are collected to

screen out the evaluation indicators, it is still difficult to avoid the situation where the evaluation indicators are not fully selected; 3) Because the age of the young male tennis players in this study is between 14-18 years old, whether this evaluation index system is suitable for professional tennis players or young female tennis players skill-related physical fitness assessment needs to be further verified.

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