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Research on the Special Fitness for 100m Swimming Based on AHP Model

Jun Xiang[1], Weiwei Huang[2], Sijia Shen[3*]
[1]School of Physical Education and Health, Zhaoqing University, Zhaoqing, Guangdong, China
[2]School of Physical Education, Guangzhou Sport University, Guangzhou, Guangdong, China
[3]China Swimming College, Beijing Sport University, Haidian District, Beijing, China
*Corresponding Author.

Abstract:

Taking the special fitness for 100m swimming as the object of study, this paper, through theoretical analyses and practical demonstrations, constructs the hierarchy factor table of the special fitness for 100m swimming, establishes the hierarchical model of the special fitness for 100m swimming, and discusses the correlation between the special fitness for 100m swimming and the 100m swimming ability, so as to provide references for 100m swimming training. This paper constructs an index system of the special fitness for 100m swimming by means of Delphi Method in the first place, then establishes the relative weight of special fitness indexes of 100m swimming by AHP, and finally analyzes the correlation between the special fitness for 100m swimming and the swimming ability through logical analysis. The special fitness structural model consists of 5 first-level indexes, 6 second-level indexes and 10 third-level indexes. Among them, the first-level indexes and their weights are as follows: speed quality (0.32); endurance quality (0.27); strength quality (0.22); flexibility quality (0.1), coordination and agility quality (0.09). The second-level indexes and their weights are as follows: displacement velocity (0.24); muscular endurance (0.23); aerobic endurance (0.21), rapid strength (0.16); specialized flexibility (0.09), specialized coordination and agility (0.07). The third-level indexes and their weights are as follows: 50m swimming (0.19); 200m swimming (0.18); 4x50m hand-stroke swimming (0.14); 4x50m leg-kick swimming (0.14); 15m swimming (0.1); shoulder extension (0.06); standing long jump (0.05); 1min superman exercise (0.05); sit and reach (0.05); 1min rope skipping (0.05). The special fitness structural model of 100m swimming constructed in this research has certain scientific and practical significance in guiding swimmers to swim. It suggests that swimmers get more training in 50m swimming, 200m swimming, 4x50m hand-stroke swimming, 4x50m leg-kick swimming and 15m swimming.

***Keywords**: Special fitness, 100m swimming, Index system, AHP.*

I. RESEARCH PURPOSE

Swimming represents a skill that people float upward under the buoyancy of the water, with which they can make the body move regularly in the water through the regular movement of their limbs. It is one of the sports well-liked by men and women, the old and the young. The 100m swimming, a periodic physical

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sport event which integrates multiple physical qualities such as strength, endurance, speed and flexibility, is no easy matter for regular swimmers. For this reason, the development of athletic constitution for 100m swimming poses a challenge to swimmers.

Athletic constitution refers to the basic athletic abilities of the body during activities, including strength, endurance, speed, flexibility and sensitivity in general. It is the outward manifestation of physical fitness and the main content of sports training [1]. Specialized athletic constitution refers to the qualities of strength, speed, endurance, flexibility and agility particularly needed for specialized sports events [2]. As part of a periodic physical event-group, the 100m swimming event requires swimmers to possess the ability to swim for 100m in line with their own rhythm, and has set higher requirements for swimmers' own athletic constitution. At present, scholars have made a start in the research on athletic constitution for swimming: they believe that the athletic constitution of swimmers in their adolescence can be categorized into strength quality, speed quality, endurance quality, flexibility quality, coordination quality and agility quality [3], and good limb strength and coordination serve to be basic physical qualities of swimmers; the comprehensive ability and performance of athletes in swimming are reflected in their swimming speed, endurance, strength and overall coordination [4]. The research results on relevant indexes of specialized quality of swimming are also quite fruitful: scholars have screened out 5 specialized physical fitness indexes related to the special performance, namely 50m freestyle, pull-up, shoulder turn, double-under and 200m freestyle, which respectively represent the special speed, special strength, special flexibility, special coordination and special endurance [5]; they have established specialized flexibility quality indexes that exert a significant impact on swimming performance, such as arm lift in prone position, medial rotation of shoulder, elbow lift in sitting posture, hip extension in prone position, hip flection in supine position, torso twist, and leg raise [6]; they have formulated the special physical fitness indexes of Chinese elite female 800m freestyle athletes aged from 14 to 17 (50m sprint swimming, pull-up, superman exercise, 20×50m swimming with hand paddle, standing long jump, 3000m freestyle, shoulder flexibility index and double-under) and their weights, and built a general model of their special physical fitness structure [7].

To sum up, there are multiple relevant research results on athletic constitution for swimming at the present stage, which provide a wealth of references for the development of this research. However, scholars mainly focus on a single swimming style such as 800m freestyle and 200m freestyle, most of the main objects involved are competitive athletes, and there are few analyses on the specialized athletic constitution for swimming events from the perspective of national fitness. As a result, this research will establish a hierarchy structure factor table of specialized athletic constitution for 100m swimming and figure out the indexes with significant characteristics. Through an analysis of the index system, this paper constructs a specialized quality model of 100m swimming. Based on the theory and method system of public swimming, this research helps swimmers further understand the characteristics of the specialized athletic constitution for 100m swimming in swimming training, and assists coaches in monitoring swimming training, so as to promote swimmers' physical health, improve swimming performance and facilitate the development of national fitness.

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II. RESEARCH METHODS

2.1 Delphi Method

Delphi Method is a method to make a statistically significant expert-cluster evaluation through a blinded experiment in which a panel of experts independently make evaluations of the research object based on their professional knowledge and experience [8-9]. The indexes of the primary index system were scored and evaluated by experts through a Likert scale. Then the primary indexes were used to calculate their weighting coefficients, and the characteristic indexes with apparent discrepancies ($X \geq 4$) would be further screened through extra questionnaires. Specifically, 12 experts (physical education teachers with at least senior title in colleges) selected through random selection answered the questionnaires independently and gave their forecast for the development of specialized quality for 100m swimming [10]. With regard to questionnaire validity, 66.67% of the experts think the validity is relatively high, 25% average and 8.33% high. Meanwhile, Split-Half Method was used to make reliability evaluation to get the correlation coefficient of the “half-test” results, 0.8263. Through data correction with Spearman-Brown formula, the split-half reliability is 0.9235, which means the questionnaires answered by the experts are highly scientific and reliable.

2.2 Analytic Hierarchy Process

Analytic Hierarchy Process (AHP) is a structured technique that considers a complex multi-target decision as a system, breaks targets down into criteria and then quantifies qualitative indexes so as to calculate priorities of AHP hierarchy. AHP has the advantage that it empowers researchers to quantify people’s subjective feeling and make quantitative analysis of qualitative things [11-12]. The index weights of specialized quality for 100m swimming were confirmed in accordance with the selected indexes, and pairwise-comparison matrix questionnaires were designed in line with the confirmed index system. The questionnaires are answered by and received from experts such as swimming coaches and physical education teachers in colleges (Totally 10 questionnaires were sent out and 10 were received, with the response rate of 100%).

III. RESULTS ANALYSIS

3.1 The Establishment of Index Evaluation System of Specialized Quality for 100m Swimming

3.1.1 The establishment of index system of specialized quality for 100m swimming.

When 100m swimming ability is considered as a system, swimming specialized quality will be one of its subsystems [10]. Since the contributions of the component factors of each subsystem to 100m swimming performance were different, the top priority in the evaluation of each subsystem is to make a scientific selection of the indexes of the subsystem, in order to get the ones that reflect the comprehensive situation of the subsystem. The selection of index system can be divided into two steps: 1) Consulting

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relevant literature and experts to confirm the index system of specialized quality for 100m swimming; 2) Screening the primary index system with the help of Delphi Method and confirming the index system of specialized quality for 100m swimming through logic reasoning.

In accordance with the principle of scientificity, operability and comprehensiveness in index system selection, the top priority in the initial stage of index selection is to collect indexes related to the evaluation of specialized quality for 100m swimming. Through qualitative analysis of relevant literature, 5 first-level indexes were confirmed: speed quality, strength quality, endurance quality, flexibility quality and coordination and agility quality. In accordance with the hierarchical thoughts in AHP, the indexes related to specialized quality for 100m swimming were displayed, and 6 second-level indexes and 26 third-level indexes were confirmed. In this way, the primary index system of specialized quality for 100m swimming came into shape. Next, in line with the principle of operability in index selection, the problems like redundancy and repetition still existed in the primary indexes [10]. To study specialized quality for 100m swimming from a more objective perspective, the primary indexes were re-selected through Delphi Method to simplify the index system. In the end, 6 second-level indexes and 10 hird-level indexes were confirmed (see TABLE I).

TABLE I. Index System of specialized quality for 100m swimming

First-level Indexes	Second-level Indexes	Third-level Indexes
Speed Quality	Displacement Speed	50m Swimming
Endurance Quality	Aerobic Endurance	200m Swimming
Strength Quality	Rapid Strength	15m Swimming
		Standing Long Jump
	Muscular Endurance	4×50m Am-stroke Simming
		4×50m Leg-kick Swimming
		1min Superman Exercise
Flexibility Quality	Specialized Flexibility	Sit and Reach Test
		Shoulder Extension
Coordination and Agility Quality	Specialized Coordination and Agility	1min Rope Skipping

3.1.2 The confirmation of index weights of specialized quality for 100m swimming

A comprehensive evaluation index system is composed of three parts: evaluation indexes, index weights and evaluation standards [9-13]. When the evaluation indexes of specialized quality for 100m swimming was confirmed, it was necessary to know the importance of each index in the whole index system so as to figure out the relative importance of each index. AHP, which transforms the weights judgement into the pairwise comparison among indexes, was used to confirm the final weight of each index [14]. After athletic constitution was considered as the target level, in-depth analysis of the practical problems included by the target level was carried out, aiming to find solutions to these problems from a quantitative perspective [10]. Then the 100w swimming specialized quality was modeled as a hierarchy. With the hierarchy, judgment matrix of elements at each level was made to confirm the weight of each

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element. The pairwise comparisons among indexes consulted the following ratio scale table of index relative importance, TABLE II (The relative importance weight is got by comparing the leftmost element with the elements in the same row (including itself)).

TABLE II. Ratio Scale of Index Relative Importance [13-14]

Relative Importance Weight	Definition
1	Equally Important
3	Slightly Important
5	Apparently Important
7	Enormously Important
9	Extremely Important
2,4,6,8	Medians Weights
Reciprocals of Above Non-zero Weighs	For example, the relative importance weight of Ai to Aj is 3, the relative importance weight of Aj to Ai is the reciprocal of 3, 1/3.

The matrix weights among the indexes were confirmed through questionnaires answered by the experts, then the eigen vector W of each index to the whole evaluation index system was finally calculated to get vector W= (w1, w2, w3, …wn). The calculation can be divided into three steps: first, building new matrix through the normalization of elements in each column and getting row vector $\overline{w}$ through the summation of elements in each row; second, getting eigen vector W through the normalization of row vector $\overline{w}$; third, calculating AW with eigen vector W and elements in each row[15]. The formulas used in the three steps are as follow:

$$\overline{b}ij = \frac{bij}{\sum_{i=1}^{n} bij}\left(i,\ j = 1,2...n\right) \qquad Wi = \frac{\overline{wi}}{\sum_{j-1}^{n} \overline{wj}}\left(\ ,i\ j = 1,2...n\ \right) \qquad AW = \lambda \max W$$

In the formula, λ_{max} refers to the max eigen value of A, and W is the corresponding eigen vector. Weight vectors were got through the normalization of W and with weight vectors, max eigen values were calculated. The formula is as follow:

$$\lambda \max = \sum_{i=1}^{n} \frac{(AW)i}{nwi}$$

After max eigen values were gained, the judgement matrix underwent consistency test in that consistency test determines the reliability of the matrix. The formulas used to get consistency index and consistency ratio are as follow:

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$$CI = \frac{\lambda \max - n}{n-1} \qquad CR = \frac{CI}{RI}$$

RI refers to average random consistency index, it can be gain from TABLE III. When CR ≦ 0.1, the matrix consistency is acceptable, otherwise, unacceptable [15].

TABLE III. The Values of Average Random Consistency Index (RI) [16]

Matrix Order n	1	2	3	4	5	6	7	8	9	10	11
RI	0.00	0.00	0.52	0.89	1.12	1.24	1.36	1.41	1.46	1.49	1.52

Take Expert 1 for example, his or her evaluation of first-level indexes (see TABLE IV) were used to calculate the weight vectors of the matrix and test the matrix consistency. The specific operations of matrix fulling and calculation are as follow:

TABLE IV. First-level Index Matrix Built by Expert 1

	Speed Quality	Strength Quality	Endurance Quality	Flexibility Quality	Coordination and Agility Quality
Speed Quality	1	1	1/5	2	2
Strength Quality	1	1	1	2	5
Endurance Quality	5	1	1	5	5
Flexibility Quality	1/2	1/2	1/5	1	3
Coordination and Agility Quality	1/2	1/5	1/5	1/3	1

① Building a new judgement matrix through normalization and then summating the elements of each row;

$$\begin{bmatrix} 0.125 & 0.270 & 0.077 & 0.194 & 0.125 \\ 0.125 & 0.270 & 0.385 & 0.194 & 0.313 \\ 0.625 & 0.270 & 0.385 & 0.484 & 0.313 \\ 0.063 & 0.135 & 0.077 & 0.097 & 0.188 \\ 0.063 & 0.054 & 0.077 & 0.032 & 0.063 \end{bmatrix} \rightarrow \begin{bmatrix} 0.791 \\ 1.286 \\ 2.076 \\ 0.559 \\ 0.288 \end{bmatrix}$$

② Getting final eigen vectors throng the normalization of row vectors;

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$$W = \begin{bmatrix} 0.791 \\ 1.286 \\ 2.076 \\ 0.559 \\ 0.288 \end{bmatrix} \rightarrow \begin{bmatrix} 0.158 \\ 0.257 \\ 0.145 \\ 0.112 \\ 0.058 \end{bmatrix}$$

③ Calculating AW and $\lambda\max$;

$$AW = \begin{bmatrix} 1 & 1 & 1/5 & 2 & 2 \\ 1 & 1 & 1 & 2 & 5 \\ 5 & 1 & 1 & 5 & 5 \\ 1/2 & 1/2 & 1/5 & 1 & 3 \\ 1/2 & 1/5 & 1/5 & 1/3 & 1 \end{bmatrix} \begin{bmatrix} 0.158 \\ 0.257 \\ 0.145 \\ 0.112 \\ 0.058 \end{bmatrix} \qquad \lambda\max = \sum_{i=1}^{n} \frac{(AW)}{nwi} = 5.316$$

When $\lambda\max$ was got, the whole judgement matrix underwent consistency test. In accordance with the formula ($CI = \frac{\lambda\max - n}{n-1}$), the consistency

index can be gain: $CI = 0.080$. With $RI = 1.12$ from TABLE III, the consistency ration can be calculated with the formula ($CR = \frac{CI}{RI}$),

CR=0.071, which is less than 0.1. Therefore, the first-level index judgement matrix built by Expert 1 is acceptable. Similarly, all 12 experts' index weights and consistency test results were calculated (see TABLE V, TABLE VI, TABLE VII).

3.1.2.1 The weight vectors and consistency test indexes of the first-level indexes of specialized quality for 100m swimming

TABLE V. First-level Index Weights and Consistency Test Indexes

Experts	W1 speed quality	W2 strength quality	W3 endurance quality	W4 flexibility quality	W5 coordination and agility quality	λmax	CI	CR
1	0.16	0.26	0.42	0.11	0.06	5.316	0.080	0.071
2	0.17	0.29	0.20	0.05	0.29	7.058	0.515	0.459*
3	0.24	0.28	0.28	0.10	0.10	5.019	0.005	0.004
4	0.25	0.34	0.21	0.11	0.09	5.236	0.059	0.053
5	0.47	0.28	0.15	0.05	0.05	5.110	0.028	0.025

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5	0.37	0.27	0.12	0.09	0.15	5.227	0.057	0.051
7	0.41	0.26	0.18	0.08	0.06	5.413	0.103	0.092
8	0.53	0.18	0.15	0.07	0.08	5.400	0.100	0.089
9	0.54	0.19	0.14	0.05	0.07	5.423	0.106	0.094
10	0.36	0.32	0.19	0.08	0.05	5.246	0.061	0.055
11	0.14	0.19	0.37	0.17	0.13	5.144	0.036	0.032
12	0.20	0.27	0.35	0.11	0.08	5.168	0.042	0.038

In TABLE V, only 1 set of judgement matrix (marked by *) is unacceptable (CR>0.1) in consistency test. After the unacceptable one was removed, the acceptable 11 sets of first-level index weights were averaged to calculate the final first-level index weights:W_1 speed quality=0.32; W_2 strength quality=0.27; W_3 endurance quality=0.22,W_4 flexibility quality=0.1; W_5 coordination and agility quality=0.09.

3.1.2.2 The weight vectors and consistency test indexes of the second-level indexes of specialized quality for 100m swimming

TABLE VI. Second-level Index Weights and Consistency Test Indexes

Experts	W1 displacement speed	W2 aerobic endurance	W3 rapid strength	W4 muscular endurance	W5 specialized flexibility	W6 specialized coordination and agility	λmax	CI	CR
1	0.35	0.28	0.11	0.17	0.06	0.03	6.357	0.071	0.058
2	0.23	0.21	0.20	0.22	0.09	0.04	6.243	0.049	0.039
3	0.24	0.28	0.12	0.21	0.09	0.05	6.275	0.055	0.044
4	0.26	0.31	0.16	0.14	0.09	0.04	5.931	-0.014	-0.011
5	0.21	0.06	0.20	0.34	0.11	0.09	6.621	0.124	0.100
6	0.28	0.13	0.20	0.28	0.06	0.05	6.297	0.059	0.048
7	0.23	0.17	0.16	0.30	0.07	0.07	6.469	0.094	0.076
8	0.27	0.25	0.06	0.23	0.09	0.09	6.409	0.082	0.066
9	0.30	0.15	0.16	0.27	0.07	0.05	6.274	0.055	0.044
10	0.11	0.13	0.18	0.28	0.18	0.13	6.596	0.119	0.096
11	0.16	0.28	0.16	0.16	0.16	0.10	6.731	0.146	0.100
12	0.24	0.16	0.19	0.27	0.08	0.07	6.462	0.092	0.075

In TABLE VI, all 12 sets of second-level index weights passed consistency test (CR≦0.1) and they were averaged to get their final index weights: W_1 displacement speed=0.24; W_2 aerobic endurance=0.21; W_3 rapid strength=0.16; W_4 muscular endurance=0.23; W_5 specialized flexibility=0.09; W_6 specialized coordination and agility=0.07.

3.1.2.3 The weight vectors and consistency test indexes of the third-level indexes of specialized quality for 100m swimming.

In TABLE VII, all 12 sets of third-level index weights passed consistency test (CR≦0.1) and they

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were averaged to get the final third-level index weights: W_1 50m swimming=0.19; W_2 200m swimming=0.18; W_3 15m swimming=0.1; W_4 4×50m leg-kick swimming=0.14; W_5 4×50m arm-stroke swimming=0.14; W_6 1min superman exercise=0.05; W_7 standing long jump=0.05; W_8 sit and reach test=0.05; W_9 shoulder extension=0.06, W_{10} 1min rope skipping=0.05.

With above data, index weights of specialized quality for 100m swimming were calculated (see TABLE VIII).

TABLE VII. Third-level Index Weights and Consistency Test Indexes

Experts	**W1 50m swimming**	**W2 200m swimming**	**W3 15m swimming**	**W44×50m leg-kick swimming**	**W5 4×50m arm-stroke swimming**	**W6 1min superman exercise**	**W7 standing long jump**	**W8 sit and reach test**	**W9 shoulder extension**	**W10 1min rope skipping**	**λmax**	**CI**	**CR**
1	0.22	0.21	0.10	0.13	0.13	0.04	0.03	0.07	0.06	0.02	11.264	0.140	0.094
2	0.17	0.15	0.14	0.16	0.15	0.03	0.03	0.07	0.07	0.03	10.374	0.042	0.028
3	0.15	0.20	0.10	0.16	0.13	0.03	0.04	0.07	0.07	0.04	10.472	0.052	0.035
4	0.25	0.21	0.13	0.09	0.15	0.02	0.04	0.05	0.05	0.02	11.003	0.111	0.075
5	0.18	0.21	0.13	0.14	0.13	0.04	0.04	0.04	0.05	0.04	10.428	0.048	0.032
6	0.21	0.20	0.21	0.10	0.11	0.01	0.02	0.05	0.05	0.04	11.422	0.158	0.106
7	0.20	0.16	0.03	0.17	0.17	0.05	0.06	0.06	0.06	0.06	10.295	0.033	0.022
8	0.21	0.24	0.02	0.15	0.14	0.06	0.06	0.02	0.05	0.05	10.841	0.093	0.063
9	0.07	0.15	0.13	0.12	0.11	0.09	0.09	0.09	0.09	0.07	10.749	0.083	0.056
10	0.22	0.11	0.08	0.16	0.16	0.06	0.03	0.05	0.07	0.05	10.654	0.073	0.049
11	0.19	0.04	0.13	0.14	0.15	0.09	0.09	0.04	0.05	0.09	10.335	0.037	0.025
12	0.20	0.20	0.11	0.14	0.14	0.04	0.04	0.05	0.05	0.04	10.826	0.092	0.062

TABLE VIII. The Index Weights of Specialized Quality for 100m Swimming

First-level Indexes	Weights	Second-level Indexes	Weights	Third-level Indexes	Weights
Speed Quality	0.33	Displacement Speed	0.25	50m Swimming	0.20
Endurance Quality	0.26	Aerobic Endurance	0.20	200m Swimming	0.17
Strength Quality	0.21	Rapid Strength	0.17	15m Swimming	0.10
				Standing Long Jump(m)	0.05
		Muscular Endurance	0.22	4×50m Arm-stroke Swimming	0.15
				4×50m Leg-kick Swimming	0.13
				1min Superman Exercise	0.06
Flexibility Quality	0.11	Specialized Flexibility	0.09	Shoulder Extension(cm)	0.05
				Sit and Reach Test(cm)	0.05
Coordination and Agility Quality	0.09	Specialized Coordination and agility	0.07	1min Rope Skipping(time)	0.05

3.2 Discussion

In the index weight model of specialized quality for 100m swimming, the first-level index weight ranking is as follows: speed quality (0.32), endurance quality (0.27), strength quality (0.22), flexibility

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quality (0.1), coordination and agility quality (0.09).

The 100m swimming ability refers to the comprehensive athletic ability that the human body, based on anaerobic energy supply system and supplemented by aerobic metabolism, can mobilize the functions of various systems to the greatest extent under the state of high-speed displacement and adapt to the environment [17]. Speed quality, endurance quality and strength quality account for 81% of the first-level index weight of the specialized quality of 100m swimming, which has set higher requirements for swimmers in terms of speed and endurance. The second-level index weight ranking is as follows: displacement speed (0.24), muscular endurance (0.23), aerobic endurance (0.21), rapid strength (0.16), specialized flexibility (0.09), specialized coordination and agility (0.07). Similarly, speed and strength endurance occupy a large weight of the second-level indexes, which is consistent with the weight structure of the first-level indexes. This has set higher requirements for the speed, endurance and strength of swimmers in 100m swimming and pointed out the training proportion of specialized quality in the athletic constitution for 100m swimming. The third-level index weight ranking is as follows: 50m swimming (0.19), 200m swimming (0.18), 4×50m arm-stroke swimming (0.14), 4×50m leg-kick swimming (0.14), 15m swimming (0.1), shoulder extension (0.06), standing long jump (0.05), 1min superman exercise (0.05), sit and reach test (0.05), 1min rope skipping (0.05).

Physical fitness is composed of body shape, body function and athletic constitution, and these three factors are independent and closely related to each other. Among them, athletic constitution is the outward manifestation of physical fitness and the basic content of physical training [2-3]. From the perspective of physiology, the proportion of various energy supply systems in swimming at different distances is varied. In 100m swimming, 25% to 80% of the energy is supplied by the phosphoric acid energy supply system, 15% to 65% by the glycolysis energy supply system, and 10% by the aerobic oxidation energy supply system [17]. Thus, it can be seen that the 100m swimming ability refers to the comprehensive athletic ability that the human body, based on anaerobic energy supply system and supplemented by aerobic metabolism, can mobilize the functions of various systems to the greatest extent under the state of high-speed displacement and adapt to the environment. The 100m swimming is mainly based on the glycolysis and metabolism system in anaerobic metabolism, which puts forward higher requirements for the athletic constitution of swimmers; In terms of speed quality, it refers to the ability of human body to move quickly, mainly including reaction, action and displacement speed [2-3]. As part of a periodic physical event-group, the 100m swimming requires swimmers to swim for 100m in accordance with their own rhythm and the swimming speed mainly depends on the swimmer's frequency and distance of arm-stroke movements. Given the relationship between resistance and the square of speed, the movement speed of arms and legs in swimming acts as one of the most imperative factors to determine the propulsion of swimming [18], which poses severe challenges to swimmers in terms of swimming rhythm and arm-stroke frequency in 100m swimming, and requires swimmers to possess great speed quality, and, more importantly, the strong ability to control speed. In terms of strength quality, it refers to the ability of human neuromuscular system to overcome or struggle against resistance at work, mainly including maximum strength, rapid strength and strength endurance [2-3]. The 100m swimming is a skill activity that enables the body to move or swim in the water by virtue of the interaction between the limb movement and the

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water [18]. In swimming, the body mainly relies on the movements of trunk, arms and legs to generate propulsion, which is usually coordinated by the muscles of the whole body, and the lower limbs are mainly responsible for three movements: leg-kicking, leaving and pushing off from the wall of basin, and turning and pushing off from the wall of basin [19]. In 100m swimming, arm movement serves as the main source of propulsion, and the muscle group around shoulder joint is the key to complete movements like holding onto water. Leg movement can not only maintain the balance of the whole body, but also produce a certain propulsion. In the course of swimming, it can also stimulate the excitement of the nervous system and adjust the frequency of the movement. Meanwhile, the trunk is the core area of the human body and the hub of the connection between hands and legs. Good core strength can help to maintain good body posture in the water and reduce the swimming resistance in the water, thus playing a better role in improving sports performance [20]. For the 100m swimming event, swimmers are required to give full play to the strength of muscles and joints within a certain period of time [21]. In this way, it puts forward higher standards for the swimmers' abilities of fast strength, strength endurance and so on; In terms of endurance quality, it refers to the ability of organisms to exercise for a long time, which is mainly divided into strength endurance and cardiovascular endurance [2-3]. As the internal basis of anaerobic endurance, good aerobic endurance helps swimmers give full play to their swimming abilities. A lot of aerobic endurance exercises must be carried out in any sports events to meet the needs of regular training and promote the recovery of the body and the elimination of lactic acid [22]. In swimming, the accumulation of lactic acid will inhibit the effect of arm-stroking and leg-kicking [23], and greatly increase the swimming resistance, thus affecting the swimming performance. For 100m swimming events dominated by physical fitness, the development of endurance quality plays a vital role in swimming ability. A certain degree of aerobic endurance training can improve cardiopulmonary function, enhance the ability of resisting against lactic acid [24], thus ensuring high-quality arm-stroking movements. In terms of flexibility quality, it refers to the movement ability of human joints in different directions and the extension ability of soft tissues such as muscles, and it is mainly reflected by the range of joint movement [2-3]. In swimming, all joints of the body are required to carry out limb movement. In addition, higher standards have been set in terms of joint flexibility in carrying out the movements like holding onto water, moving arms quickly in the air, kicking legs and extending hip joints [19]. Good joint flexibility can ensure larger water pushing area, increase swimming efficiency, and improve swimming performance [20]. In 100m swimming, good joint flexibility can make swimmers stretch the limbs as much as possible in the process of swimming, increase the body's area against water, fully mobilize each muscle group of the body, thus giving full play to the swimming technique. In terms of coordination and agility quality, it refers to the ability of athletes to complete technical movements with the cooperation of different systems and organs of the body [3]. The agility quality refers to the ability to quickly and accurately change the spatial position and direction of body movement under various sudden changing conditions, so as to adapt to the changing external environment [2]. The 100m swimming event is a movement by limb activities. In the water, factors like changes in the direction of arm and leg movements will directly affect the quality of arm-stroke movement, thus influencing the swimming performance [24]. The completion of these movements and the changes of movement direction are closely related to the development of swimmers' coordination and agility quality. Hence,the index model of athletic constitution for 100 swimming constructed in this research has certain practical values for guiding swimmers to swim.

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IV. CONCLUSION AND SUGGESTION

4.1 Conclusion

According to the foundation, process and principle of the index system, the index system of specialized quality for 100m swimming is established through the methods of literature, expert investigation and relevant statistics. The system includes 5 first-level indexes: speed quality, strength quality, endurance quality, flexibility quality, coordination and agility quality, 6 second-level indexes: displacement speed, rapid strength, strength endurance, aerobic endurance, specialized flexibility, specialized coordination and agility, and 10 third-level indexes: 50m swimming, 200m swimming, 15m swimming, 4×50m leg-kick swimming, 4×50m arm-stroke swimming, 1min superman exercise, standing long jump, sit and reach test, shoulder extension and 1min rope skipping. Meanwhile, on the basis of the basic idea and logic of analytic hierarchy process, this paper constructs the judgment matrix of index system, establishes the index model of specialized quality for 100m swimming, and analyzes the correlation between the specialized quality for 100m swimming and swimming ability.

4.2 Suggestion

It is suggested that swimmers strive to improve displacement speed, strength endurance, aerobic endurance, fast strength, special flexibility, special coordination and sensitivity in the development of specialized physical fitness. Swimmers should reasonably arrange the proportion of water and land training. For aquatic training, they should conduct arm-stroke swimming and leg-kicking swimming at a distance of 50m to 200m. For land training, they should carry out more flexibility training and core strength training, do more comprehensive exercises of specialized quality such as shoulder extension, shoulder stretch and rope skipping, and get more exercises in 4×50m arm-stroke swimming, 4×50m leg-kick swimming, 50m swimming, 200m swimming and 15m swimming.

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