

The Sport Quality Indicator Weight Research of Taekwondo Athletes Based On Principal Component Analysis

Zhiming Qin, Yuhong Cui, Huahei Jiang

Hebei Institute of Physical Education

Shijiazhuang 050041, Hebei, China

tiyuxi@qq.com

Abstract—This paper filters out the sport quality evaluation indicators of taekwondo athletes' special physical stamina through the questionnaire and mathematical statistics method and finally determines the specific evaluation indicator to measure Taekwondo special physical stamina through the process of mathematical statistics. Taking the sport quality indicators of Taekwondo athletes' special physical stamina for example, this paper uses principal component analysis method, evaluates the comprehensive evaluation level of each sport quality indicator of taekwondo athletes' special physical stamina, determines the importance and weight of each indicator, establishes the indicator evaluation criteria of Taekwondo Athletes' sport quality, and provides a theoretical basis for the daily training of taekwondo coaches and athletes.

Keywords—Taekwondo; special athletic qualities; weight

I. INTRODUCTION

Taekwondo is an athletic sport project and has had a 15 year history in the country. During a short period of fifteen years, our athletes achieved quite good results by virtue of efforts, especially woman taekwondo athletes obtained three Olympic gold medals, five world championship gold medals and three World Cup gold medals. Thus the taekwondo was classified as the dominant athletic project by the State Sports General Administration in 2007 [1-3].

However, in recent years, with Europe and the United States' paying attention to the athletic project and the continuous development of the Taekwondo rules, Taekwondo techniques and tactics have developed from the original skill flexibility to strong confrontation. Along with the continuous improvement of modern Taekwondo competitive level, Taekwondo's competitive strength continues to increase, as well as its confrontation has greatly enhanced, which put forward higher and more stringent requirements for the physical fitness of athletes, and which require Taekwondo players to keep the high coordinated development of athletic ability elements like

the stamina, tactics, techniques, intelligence and psychology [4-6]. Therefore, specific to the physical characteristics and technical and tactical characteristics of taekwondo athletes, the establishment of what kind of evaluation indicators, the adoption of which specialized means to increase and develop physical fitness, physiological functions and special athletic ability related with Taekwondo stamina has become a new topic to be solved.

II. SPORT QUALITY INDICATOR SYSTEM OF TAEKWONDO ATHLETES

Through expert interviews and questionnaire survey, this paper obtained sport quality evaluation indicator of Taekwondo Athletes considering the various requirements [7]:

TABLE I. SPORT QUALITY INDICATOR SYSTEM OF TAEKWONDO ATHLETES

First Level indicators	Secondary level indicators
A1 Power	B1 Power clean; B2 Half squat B3 Standing triple jump
A2 Speed	B4 Backward cross-kicking 30 seconds
A3 Flexibility	B5 Parallel split B6 Meet head-on downward split
A4 Sensitivity	B7 Identification run
A5 Coordination	B8 One minute rope skipping
A6 Endurance	B9 One minute thong kicking target B10 800m

III. RELIABILITY TEST OF THE INDICATORS

In order to verify the reliability of the indicators selected this paper conduct statistical analysis on the correlation coefficient of the measured data for collected taekwondo athletes, as shown in Table 2 [8].

TABLE II. RELIABILITY ANALYSIS OF SPORT QUALITY TEST INDICATORS

Item	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
R	= 0.91	= 0.92	= 0.90	= 0.87	= 0.89	= 0.89	= 0.91	= 0.88	= 0.93	= 0.86
P	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
T	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05	> 0.05

As described in Table 2, the selected indicators have a significant correlation, indicating that test indicators selected are reliable, and the selection of indicators is reasonable.

IV. STATISTICAL ANALYSIS ON THE QUALITY INDICATORS OF TAEKWONDO ATHLETES

This article extracted 10 indicators, on the basis of existing literature, used factor analysis method to conduct in-depth study of the selected indicators, and conducted mathematical statistical analysis of the raw test data. It first carry through *KMO* and *Bartlett* test to see if it is suitable for factor analysis.

TABLE III. *KMO* AND *Bartlett* TEST

Kaiser – Meyer – Olkin Measurement	.75
Sphericity degree test of <i>Bartlett</i>	Approximate chi-square
<i>D</i>	208.87
<i>F</i>	46
<i>Sig.</i>	.000

As shown in Table 3, the value of Kaiser – Meyer – Olkin is 0.710 (the range of *KMO* is 0-1, the closer to 1, the more suitable for factor analysis. This time the value of *KMO* is 0.75 above moderate degree); the sphericity degree test of *Bartlett*: approximate chi-square value is 208.87, and the degrees of freedom is 46; *Sig.* (significant level) is $0.000 < 0.01$, reaching a significant level.

TABLE IV. COMMON DEGREE OF INDICATORS

Initial	Extract	
Standing triple jump	1.00	.95
One minute rope skipping	1.00	.66
Identification run	1.00	.89
Backward cross-kicking 30 seconds	1.00	.99
Power clean	1.00	.85
Half squat	1.00	.96
Parallel split	1.00	.43
800 meters	1.00	.93
One minute thong kicking target	1.00	.99
Meet head-on downward split	1.00	.77

Table 4 shows the common degree of each indicator (common degree is the square sum of the factor loadings of the indicators), which represents the all factors' total variance contribution to the change amount. The greater

the contribution is, the greater common degree is, meaning that it is more on behalf of the problem to be explained, and can more effectively explain the special sport quality. Usually when the common degree is not less than 0.4, the selected common factor can well explain the indicators. As displayed in the table above, the common degrees of each indicator are all respectively greater than 0.4. The minimum is 0.43 and the maximum is 0.99. Indicators selected in this article have high representative ness.

TABLE V. THE TOTAL VARIANCE EXPLAINED

Component	Initial characteristic value			extraction square and load			rotation square and load		
	Total variance%	Cumulative%		Total variance%	Cumulative%		Total variance%	Cumulative%	
1	5.43	54.32	54.314	5.43	54.31	54.32	4.23	42.35	42.36
2									
3	1.54	15.40	69.714	1.54	15.40	69.71	2.41	24.17	66.53
	1.13	11.27	80.986	1.13	11.27	80.99	1.44	14.45	80.98
4	.92	9.22	90.22						
5	.59	5.93	96.15						
6	.23	2.18	98.33						
7	.08	.80	99.13						
8	.06	.55	99.68						
9	.03	.27	99.94						
10	.01	.06	100.00						

In Table 5 we conduct factor analysis of the 10 indicators selected, and obtain the total variance explained. There are a total of 10 components in this table; three eigenvalue are greater than 1. So this paper selected these three factors, and the cumulative contribution rate of three factors is 80.98.

As can be seen from Table 6, we after extracted three factors from the analysis results after the rotation, In the first factor high-load variables contain identification run, Power clean, eight hundred meters, standing triple jump, backward cross-kicking, half squat and one minute thong kicking target; in the second factor high-load variables contain one minute rope skipping; in the third factor high-load variables contain meet head-on downward split and Parallel split. Seen from the indicator name and the connotation, the first factor composites the upper limb explosive forces, the supporting strength, the lower limb explosive forces, reaction speed, speed endurance and anaerobic endurance; the second factor integrated coordination capacity; the third factor integrated the flexibility in static and dynamic case. The three categories of factors explained the requirement of the game on athlete's sports quality from different aspects. Taekwondo competition is the winning or losing athletic event according to the score in a limited space and limited period of time. The athletes can ensure victory only through active attack and effective defense. Taekwondo attack requires athletes to rapidly converse into a single leg

supporting from stable conditions of both legs supporting, and complete the hit, which requires athletes with good speed strength and lower limb supporting ability. In addition, under the rapid conversion of the offensive and defensive, athletes need to accurately and timely judge the intent of the opponent, agilely move, and coordinately complete the transition action. These are very in line with the cluster analysis of selected indicators, verifying that the selected indicators can be used to descript special athletic quality level of taekwondo athletes.

TABLE VI. COMPONENT MATRIX

Component			
	1	2	3
Standing triple jump	.94	-.23	-.10
One minute rope skipping	.20	.74	-.27
Identification run	-.93	.09	.13
Backward cross-kicking 30 seconds	.71	.37	.58
Power clean	.86	-.26	-.21
Half squat	.94	-.12	-.23
Parallel split	.29	.21	-.83
800 meters	-.94	.04	.22
One minute thong kicking target	.72	.39	.56
Meet head-on downward split	.12	-.72	.88

Each measurement indicator of the sport quality is extremely important to athletes' athletic level. But in the overall indicators have different contribution rates. In order to better understand the important degree of various sport quality indicators and objectively evaluate them, this paper obtained the weight of each indicator in the Taekwondo athlete's special sports quality system through the processing of the data in the table (weight formula), then determine the weight according to the formula:

$$T_i = \frac{a_{i1}}{\sum_{k=1}^5 |a_{k1}|} + \frac{a_{i2}}{\sum_{k=2}^5 |a_{k2}|} + \frac{a_{i3}}{\sum_{k=3}^5 |a_{k3}|}$$

Wherein, $\sum_{k=1}^5 |a_{k1}|$ means the index weight coefficient in the formula: represents the initial variable of the j -th main factor, a_{k1} means the sum of the initial factor loading.

$$\begin{aligned} \sum_{k=1}^5 |a_{k1}| &= 0.94 + 0.20 + |-0.93| + 0.71 + 0.86 \\ &+ 0.94 + 0.29 + |-0.94| + 0.72 + 0.12 = 6.65 \end{aligned}$$

$$\begin{aligned} \sum_{k=1}^5 |a_{k2}| &= |-0.23| + 0.74 + 0.09 + 0.37 + |-0.26| \\ &+ |-0.12| + 0.21 + 0.04 + 0.39 + |-0.72| = 3.17 \end{aligned}$$

$$\begin{aligned} \sum_{k=1}^5 |a_{k3}| &= |-0.10| + |-0.27| + 0.13 + 0.58 + |-0.21| \\ &+ |-0.23| + |-0.83| + 0.22 + 0.56 + 0.88 = 4.01 \end{aligned}$$

$$T_1 = \frac{0.94}{6.65} + \frac{0.23}{3.17} + \frac{0.10}{4.01} = 0.24$$

$$T_2 = \frac{0.20}{6.65} + \frac{0.74}{3.17} + \frac{0.27}{4.01} = 0.32$$

$$T_3 = \frac{0.93}{6.65} + \frac{0.09}{3.17} + \frac{0.13}{4.01} = 0.20$$

$$T_4 = \frac{0.71}{6.65} + \frac{0.37}{3.17} + \frac{0.58}{4.01} = 0.38$$

$$T_5 = \frac{0.86}{6.65} + \frac{0.26}{3.17} + \frac{0.21}{4.01} = 0.26$$

$$T_6 = \frac{0.94}{6.65} + \frac{0.12}{3.17} + \frac{0.23}{4.01} = 0.24$$

$$T_7 = \frac{0.29}{6.65} + \frac{0.21}{3.17} + \frac{0.83}{4.01} = 0.32$$

$$T_8 = \frac{0.94}{6.65} + \frac{0.04}{3.17} + \frac{0.22}{4.01} = 0.21$$

$$T_9 = \frac{0.72}{6.65} + \frac{0.39}{3.17} + \frac{0.56}{4.01} = 0.37$$

$$T_{10} = \frac{0.12}{6.65} + \frac{0.72}{3.17} + \frac{0.82}{4.01} = 0.45$$

Do uniform normalization process on the resulting T_i , the result is:

$$T_1 = \frac{0.24}{0.24 + 0.32 + 0.20 + 0.38 + 0.26 + 0.24 + 0.32 + 0.21 + 0.37 + 0.45} = 0.08$$

$$T_2 = \frac{0.32}{0.24 + 0.32 + 0.20 + 0.38 + 0.26 + 0.24 + 0.32 + 0.21 + 0.37 + 0.45} = 0.11$$

$$T_3 = \frac{0.20}{0.24 + 0.32 + 0.20 + 0.38 + 0.26 + 0.24 + 0.32 + 0.21 + 0.37 + 0.45} = 0.07$$

$$T_4 = \frac{0.38}{0.24 + 0.32 + 0.20 + 0.38 + 0.26 + 0.24 + 0.32 + 0.21 + 0.37 + 0.45} = 0.13$$

$$T_5 = \frac{0.26}{0.24+0.32+0.20+0.38+0.26+0.24+0.32+0.21+0.37+0.45} = 0.09$$

$$T_6 = \frac{0.24}{0.24+0.32+0.20+0.38+0.26+0.24+0.32+0.21+0.37+0.45} = 0.08$$

$$T_7 = \frac{0.32}{0.24+0.32+0.20+0.38+0.26+0.24+0.32+0.21+0.37+0.45} = 0.11$$

$$T_8 = \frac{0.21}{0.24+0.32+0.20+0.38+0.26+0.24+0.32+0.21+0.37+0.45} = 0.07$$

$$T_9 = \frac{0.37}{0.24+0.32+0.20+0.38+0.26+0.24+0.32+0.21+0.37+0.45} = 0.12$$

$$T_{10} = \frac{0.45}{0.24+0.32+0.20+0.38+0.26+0.24+0.32+0.21+0.37+0.45} = 0.14$$

Through factor loading matrix and the weight formula, calculate the weights of the 10 indicators are respectively: standing triple jump accounts for 8%; one minute single shake rope skipping accounts for 11%; identification run accounts for 7%; backward cross-kicking 30 seconds accounts for 13%; power clean accounts for 9%; half squat accounts for 8%; parallel split accounts for 11%; 800 meters accounts for 7%; one minute thong kicking target accounts for 12%; meet head-on downward split accounts for 14%.

Seen from research, the index weights of sports quality from high to low respectively are backward cross-kicking 30 seconds, one minute thong kicking target, meet head-on downward split, identification run, power clean, one minute single shake rope skipping, half squat, standing triple jump, parallel split and 800 meters. Time characteristics of the taekwondo competition are shown in round. In each game of the match only through being coordinate close to or away from the opponent can athletes get the opportunity to score quickly. The athletes must have good movement speed and coordination ability. The scoring process is slightly instantaneous disappearing.

Only with good speed endurance (maintain fast and frequent hits within a certain period of time) and body flexibility (mobility of hip joint), can the athletes ensure to hit the opponent or even hit high place, so as to ensure to get higher scores. When the athletes quickly carry out offensive to the opponent, whether one can react from the action of the opponent and the attack effect of hitting directly determine the action effect, which requires athletes to have a good response rate, be sensitive to make response, meanwhile ensure accurate and powerful hit. Of course, the Taekwondo match is not a bureau decided. Whether the athletes can maintain a rapid, coordinated and sensitive state in the later-course of the race in most cases all depends on the level of the endurance quality.

V. CONCLUSIONS

Through the above analysis, we can see that the results of this paper are entirely consistent with the quality requirements for Taekwondo athletes of this project's characteristics. Thus indicator weight analysis of the Taekwondo athlete's specialized sport quality in this article is reasonable. Coaches and athletes can appropriately arrange indicator training in accordance with the weight of each index, which provides a reference for scientifically and reasonably raising the level of Taekwondo in China.

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