



Research on physical quality evaluation of competitive wushu athletes based on fuzzy median information

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SUMMARY: *In competitive wushu sports, athletes' physical quality test values are often between two levels, forming an intermediate state of fuzzy middle information. This paper takes excellent competitive wushu athletes in province A as the subject, and constructs the evaluation system of body item quality of excellent athletes in competitive wushu through the specific measurement, statistics and research of general physical quality and special physical quality combined with the physical quality indexes characterized by competitive wushu. Introducing the concept of fuzzy middle information, combining the cloud model to improve the fuzzy comprehensive evaluation, establishing a multi-level fuzzy comprehensive cloud evaluation model, and applying it to the evaluation of physical quality of the subjects. The results show that most of the secondary indicators of physical quality of the members of the Wushu team are in the upper range of "general", and the evaluation results of the comprehensive physical quality level are close to "good". The degree of certainty is centered between 0.8 and 1, and the evaluation results are reliable.*

KEYWORDS: *competitive wushu; physical quality; evaluation system; fuzzy comprehensive evaluation; cloud modeling*

1 Introduction

Competitive wushu refers to high-level wushu competition, which is a wushu training and competition activity in order to maximize individual athletic potential and strive for excellent results, and it is characterized by specialization, professionalism, high level, overload, and outstanding athleticism. Especially after the 2008 Beijing Olympic Games, competitive sports have become stronger, faster, and more scientific, and Wushu sets of sports also follow the trend of the times [1-3]. Physical quality is an important foundation for competitive wushu athletes to obtain a high level of competitive ability, athletes only have a good physical quality, it is possible to adapt to the "high, difficult, new, beautiful" in the competitive wushu routines in the skills and artistic expression, so as to dominate in the fierce competition, in the level of rehearsal to obtain high scores in the quality of the movement and the difficulty of the movement to get full marks! The same is true for the Nanquan program, which has a high score in terms of rehearsal level, quality of movement and difficulty of movement. This puts forward higher and higher requirements on the physical quality of athletes in competitive wushu routines. Good physical quality not only promotes the faster and more comprehensive mastery of the movement techniques of Nanquan athletes, but also is a powerful guarantee for athletes to complete each movement with high quality in the whole set of rehearsals, and also reduces the occurrence of sports injuries and prolongs the life span of the sport [4-7].

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With the continuous development of competitive wushu and the continuous improvement of the competition rules, the focus of training methods and means also change, some of the athlete's physical quality will inevitably produce adaptive changes, which in turn affects the athlete's physical quality of the indicators with the overall development of competitive wushu routines program and the corresponding adjustment [8-10]. Therefore, it is necessary to keep abreast of the times and develop a scientific and reasonable physical quality assessment framework to ensure that it can accurately reflect the current physical quality characteristics of outstanding competitive wushu athletes.

For a special study on the evaluation of physical fitness of wushu athletes, Volodchenko et al [11] (2017) collected physical data of wushu athletes by means of sensors, added a series of psychophysiological methods to analyze the state of physical functioning of wushu athletes of striking and fighting categories, with the better skills of freestyle fighters. Katamanova et al. [12] (2020) assessed the physical fitness of wushu athletes, including their health and physical development, using the "Health-Express" software system, and more than 50% of the athletes were in good physical condition. Nurhidayah et al [13] (2024) developed a physical fitness testing instrument for retired martial arts athletes containing physical fitness indices such as body composition, flexibility, muscular strength, and cardiovascular endurance, which was evaluated and shown to have validity and reliability.

In addition, scholars have developed generalized physical fitness assessment systems and methods. Li, L [14] (2019) used data mining technology to integrate athletes' multi-party data, which was realized through athletes' sports training auxiliary decision support system, and in this way constructed athletes' physical training assessment indexes and index system. Li, J [15] (2021) constructed an IoT-based real-time monitoring platform for collecting athletes' data, introduced a linear acceleration energy estimation model, and proposed an athlete-specific physical fitness assessment method. Henriques-Neto et al [16] (2020) analyzed the reliability of the F1 assessment system for physical fitness testing of young athletes, and the results showed that the system could assess the physical fitness of athletes with different sports backgrounds. However, at present, the research on the evaluation of physical fitness of competitive wushu athletes is still in its infancy, and most of the evaluation indexes are limited to strength, speed, endurance, flexibility, and for the integration of indicators such as balance, sensitivity and coordination. In addition, most evaluations are distinguished by the grades of excellent, good and poor, but there is ambiguity between the grade distinctions, which makes it difficult to accurately judge the physical quality status of athletes.

In this paper, the basic idea of fuzzy comprehensive evaluation and the idea of constructing the affiliation function are firstly systematically sorted out, and an improved fuzzy comprehensive evaluation method is proposed in combination with the cloud model. For the uncertainty existing in the evaluation process, the cloud model is quoted to characterize the importance scale, comment set and affiliation function. The physical quality test data of the members of a well-known martial arts team in Province A are selected to carry out empirical analysis. Through expert interviews, questionnaire surveys and expert screening, 14 physical quality evaluation indexes of competitive wushu athletes were selected. The evaluation standard cloud was calculated, and the parameters of each index cloud were obtained by combining the scoring results of experts. Judge the evaluation intervals of the six dimensions of strength, speed, endurance, flexibility, sensitivity and coordination, and calculate the fuzzy comprehensive evaluation results. Verify the reliability of the evaluation results based on the evaluation value certainty distribution.

2 Improvement of the design of fuzzy comprehensive evaluation methods in conjunction with cloud modeling

Fuzzy mediating information refers to the mediating region where the state of the evaluation object is neither completely attributed to a certain determined level nor completely detached from its neighboring levels, but distributed in multiple levels with a certain degree of affiliation in an uncertain environment. The traditional evaluation method ignores such intermediary characteristics, which is easy to lead to the distortion of evaluation. For this reason, based on the fuzzy comprehensive evaluation, this paper introduces the cloud model to transform the fuzzy mediator information into the cloud model parameters, aiming to reflect the evaluation information more objectively.

2.1 Fuzzy integrated evaluation

2.1.1 Basic idea

The evaluation of many things is determined by multiple factors, and their boundaries are not very clear. It is difficult to classify them into a certain category when evaluating. Therefore, we first evaluate individual factors and then conduct a comprehensive and fuzzy evaluation of all factors to prevent the omission of any statistical information and the loss of information during the process. This helps to solve the problem of deviation from objective truth caused by deterministic evaluations such as "yes" or "no".

A fuzzy set on the domain U is characterized by an affiliation function $U(x)$, $U(x)$ taking values in the range $[0,1]$. A fuzzy set is a generalization of a classical set that allows the affiliation function to take any value in the interval $[0,1]$.

Let $U = \{u_1, u_2, \dots, u_n\}$ be n kinds of factors (or indicators), and $V = \{v_1, v_2, \dots, v_m\}$ be m kinds of judgments, for m kinds of judgments is not absolutely affirmative or negative, but gives the degree of affiliation of each kind of factor belonging to each kind of judgment v_j , and the degree of affiliation of u_i to v_j has an affiliation degree of r_{ij} , thus a judgment matrix R is obtained as follows:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad (1)$$

$W = [w_1 \ w_2 \ \cdots \ w_n]$, where w_j reflects the weight of the evaluation of the j th factor $r_j = [r_{j1} \ r_{j2} \ \cdots \ r_{jm}]$ in the comprehensive evaluation. Therefore, the comprehensive assessment P should be obtained by combining the assessments of the factors and their weights, calculated by the formula:

$$P = W \cdot R = [w_1 \ w_2 \ \cdots \ w_n] \cdot \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & \ddots & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} = [p_1 \ p_2 \ \cdots \ p_m] \quad (2)$$

2.1.2 Construction of subordinate functions

Considering the characteristics of the assessment sets in this paper, the affiliation functions are constructed by using the trapezoidal distribution, Γ -shaped distribution's, etc. for different assessment sets respectively. Assuming that the assessment set $V = \{v_1, v_2, v_3, v_4\}$ corresponds to scores of $\{[a, +\infty), [b, a), [c, b), (-\infty, c)\}$, then the affiliation function is constructed as:

(1) The degree of affiliation of u_i to v_1

$$r_{i1} = \begin{cases} 1, & \text{If } u_i \geq a \\ \frac{u_i - b}{a - b}, & \text{If } b \leq u_i < a \\ 0, & \text{Other} \end{cases} \quad (3)$$

(2) The affiliation of u_i to v_2

$$r_{i2} = \begin{cases} 1, & \text{If } b \leq u_i < a \\ \frac{u_i - c}{b - c}, & \text{If } c \leq u_i < b \\ e^{-k(u_i - a)}, & \text{If } u_i \geq a \\ 0, & \text{Other} \end{cases} \quad (4)$$

(3) The affiliation of u_i to v_3

$$r_{i3} = \begin{cases} 1, & \text{If } c \leq u_i < b \\ \frac{a - u_i}{a - b}, & \text{If } b \leq u_i < a \\ e^{k(u_i - c)}, & \text{If } u_i < c \\ 0, & \text{Other} \end{cases} \quad (5)$$

(4) The affiliation of u_i to v_4

$$r_{i4} = \begin{cases} 1, & \text{If } u_i < c \\ \frac{b - u_i}{b - c}, & \text{If } c \leq u_i < b \\ 0, & \text{Other} \end{cases} \quad (6)$$

In equations (4) and (5) above, k is a positive number. For some indicators, a change of 0.2 in performance results in a correspondingly large change in the degree of affiliation, while for some indicators, a change of 10 in performance does not change the value of the degree of affiliation much. In order to control the rate of change of the affiliation with the indicator's grade, a suitable value of k can be chosen. This is why the affiliation function with Γ shaped distribution is chosen in this paper; other forms of affiliation functions do not achieve such control.

The value of k should be taken so that the affiliation of the near-best score \max to v_2 (good) is close to 0, so that the median of a and \max to v_2 (good) is less than 0.5; so that the median of the worst score \min and c to v_3 (medium) is less than 0.5. Taking these conditions into account, the latter corresponding k values are given in the affiliation function for each indicator.

2.2 Cloud Modeling Improved Fuzzy Comprehensive Evaluation

An improved fuzzy integrated evaluation method based on cloud modeling with focus on:

$$En = \frac{En_1(Ex_2 - Ex) + En_2(Ex - Ex_1)}{Ex_2 - Ex_1} \quad (7)$$

$$He = \frac{He_1(Ex_2 - Ex) + He_2(Ex - Ex_1)}{Ex_2 - Ex_1} \quad (8)$$

where β is an adjustable coefficient indicating the degree of influence of the judgment cloud on the floating cloud, which can be determined according to the specific situation.

Similarly, when there are n judgment clouds clustered, the algorithm of the floating cloud is as Eqs. (9) to (11).

$$Ex = a_1Ex_1 + a_2Ex_2 + \dots + a_nEx_n \quad (9)$$

$$En = \frac{a_1Ex_1En_1 + a_2Ex_2En_2 + \dots + a_nEx_nEn_n}{a_1Ex_1 + a_2Ex_2 + \dots + a_nEx_n} \quad (10)$$

$$He = \sqrt{He_1^n + He_2^n + \dots + He_n^n} \quad (11)$$

The evaluation cloud model given by the assembled group of experts is synthesized to obtain the importance comparison judgment matrix of the formal representation of the cloud model.

$$\begin{bmatrix} \dots & En_{12}, He_{12} & \dots & C_{1n}(Ex_{1n}, En_{1n}, He_{1n}) \\ \dots & \dots & \dots & \vdots \\ \vdots & \vdots & \vdots & \vdots \\ \dots & \dots & \dots & C_{mn}(Ex_{mn}, En_{mn}, He_{mn}) \end{bmatrix} \quad (12)$$

The cloud model is used to construct a fuzzy affiliation function, presenting a one-to-many fuzzy mapping between qualitative concepts and exact values, with the cloud expectation Ex

denoting the center of the affiliation thesis, the entropy En denoting the degree of discretization of the affiliation to the thesis to reflect the event ambiguity, and the hyperentropy He denoting the degree of deviation from the truth of the affiliation from the thesis to reflect the event stochasticity.

2.2.1 Establishment of a rubric

The cloud model is obtained using the $3En$ rule of cloud modeling i.e., Eq. (13) to generate a cloud model of the comment set.

$$\begin{cases} Ex = (B_{\max} + B_{\min}) / 2 \\ En = (B_{\max} - B_{\min}) / 6 \\ He = k \end{cases} \quad (13)$$

where B_{\max}, B_{\min} are quantitative interval boundary values for qualitative concepts; k is a constant, here let $k = 0.1$.

2.2.2 Constructing a cloud model of indicator affiliation functions

The cloud model is used to establish the affiliation function in traditional fuzzy mathematics, and the improved affiliation calculation process of the cloud model is as follows: in the evaluation domain $V = \{V_1, V_2, \dots, V_m\}$, n experts are invited to evaluate the evaluation indicator factors, then i can be given n evaluation cloud models for the indicator factors i , and we get the evaluation set of the indicator factors i , $V_i = \{C_i^1, C_i^2, \dots, C_i^n\}$, C_i^j that is, the evaluation cloud model of expert j on indicator i (where $i = 1, 2, \dots, m; j = 1, 2, \dots, n$). The following formula is used to synthesize the set of evaluation cloud models to obtain the synthesized evaluation cloud model $C_i = (Ex_i, En_i, He_i)$ for indicator factor i .

$$\begin{cases} Ex_i = \frac{Ex_i^1 \times En_i^1 + Ex_i^2 \times En_i^2 + \dots + Ex_i^n \times En_i^n}{En_i^1 + En_i^2 + \dots + En_i^n} \\ En_i = En_i^1 + En_i^2 + \dots + En_i^n \\ He_i = \frac{He_i^1 \times En_i^1 + He_i^2 \times En_i^2 + \dots + He_i^n \times En_i^n}{En_i^1 + En_i^2 + \dots + En_i^n} \end{cases} \quad (14)$$

2.2.3 Fuzzy Integrated Cloud Evaluation

Evaluate and cloud synthesize m indicator factors respectively, obtain m evaluation cloud models $C_1 = (Ex_1, En_1, He_1), C_2 = (Ex_2, En_2, He_2), \dots, C_m = (Ex_m, En_m, He_m)$, and construct evaluation fuzzy relationship matrix V .

$$V = [C_1, C_2, \dots, C_m] = [(Ex_1, En_1, He_1), (Ex_2, En_2, He_2), \dots, (Ex_m, En_m, He_m)] \quad (15)$$

Layer by layer, the fuzzy relationship matrix V and the weight set W are subjected to fuzzy operations, and finally the evaluation eigenvalue cloud model R is obtained.

$$R = V \cdot W = C = [Ex, En, He] \quad (16)$$

The eigenvalue cloud model R is the evaluation cloud model of the evaluation object level, and according to the principle of maximum affiliation, the expected value of the eigenvalue cloud model R E_x is closest to the expected value of which rubric set cloud model, i.e., the rubric is the evaluation result.

3 Empirical Analysis of Physical Quality Evaluation of Competitive Wushu Athletes Based on Fuzzy Median Information

The purpose of this paper is to build a physical quality evaluation system for Chinese outstanding competitive wushu athletes, in order to provide coaches and athletes with an intuitive scientific evaluation of the current situation of physical quality, and to help implement targeted training and effective monitoring. Through the nationwide competitive wushu outstanding athletes for physical fitness test, the relevant data obtained for statistical analysis, the establishment of competitive wushu athletes physical fitness evaluation system, for athletes physical fitness development level diagnosis and the implementation of effective intervention training to play a guiding role. The data of this paper comes from the members of a well-known wushu team in Province A. The subjects are all excellent athletes who have participated in the National Wushu Circuit Championship and the National University Wushu Circuit Championship in recent years, among which there are 20 male and 20 female athletes each.

3.1 Construction of physical quality evaluation index system for competitive wushu athletes

3.1.1 Process for establishing indicators

In the practical research in the field of sports, the method of determining indicators and the screening of the indicator system have formed a set of independent and effective methods and processes, which generally follow the following three steps:

(1) Determine the preliminary selection of indicators with the support of theory and logical analysis.

(2) The first round of screening of the preliminary selection of indicators is carried out through the experience of relevant experts.

(3) Measurement of the indicators established after expert screening and a second round of statistical screening of the results, usually using methods such as stepwise regression analysis or principal component analysis.

The process of screening and establishing indicators in this paper goes through three steps of preliminary selection of indicators, expert screening and finalization of indicators, and the specific process is shown in Figure 1.

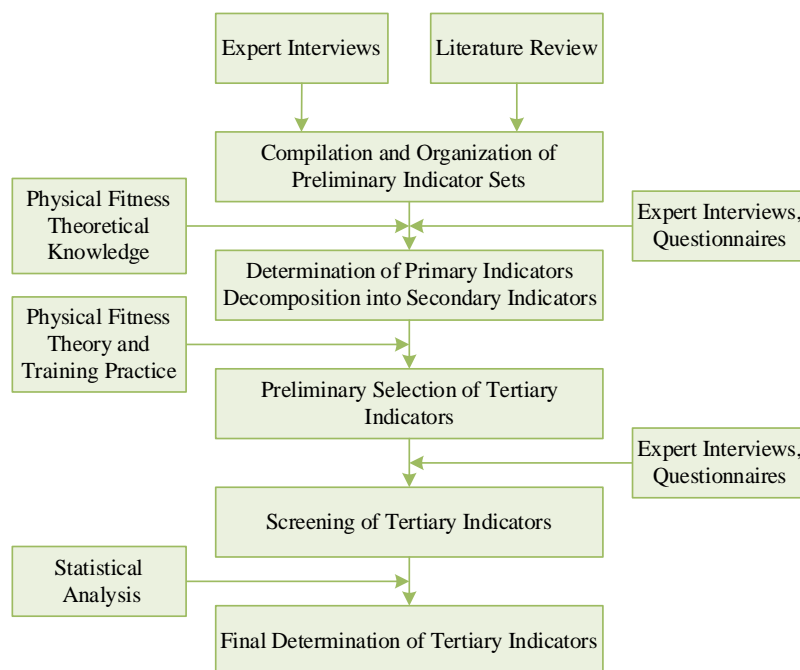


Figure 1: Screening process of physical fitness indicators

3.1.2 Identification of indicators

According to the research purpose and requirements of this paper, based on the knowledge of sports training science, sports physiology and anatomy, and with some reference to the research methods of the predecessors, the first-level indicators of physical quality were decomposed, and the second-level indicators of strength, speed, endurance, flexibility, sensitivity and coordination were derived in six items. According to the purpose of the physical quality evaluation system, interviews were conducted with senior wushu routine experts in the industry, national team and provincial and municipal team coaches and athletes at opportunities such as domestic championships, city games, university championships, referee and coach training conferences, etc. A three-level preliminary index as comprehensive as possible was set up on the basis of the secondary indexes, so as to provide a more comprehensive index for the next step of screening out athletes who can accurately reflect China's competitive wushu physical quality development level to provide a broader platform.

This article adopts the expert questionnaire method to screen test indicators, designs and distributes expert questionnaires, and uses the Delphi method for consultation. For each indicator, a five-level ten-grade scoring method is adopted, with five grades: "not important", "relatively important", "average", "important", and "very important". Experts select the significance of each of the three-level indicators reflecting the physical fitness of competitive martial arts athletes and assign values to all indicators: 0 for "not important", 1-3 for "relatively important", 4-6 for "average", 7-9 for "important", and 10 for "very important". After expert scoring and assignment, the obtained data were statistically analyzed using the weighting method. A total of 50 questionnaires were distributed, and all 50 were retrieved, achieving a 100% retrieval rate and an effective rate of 100%. The weighted statistical results of the importance assignment of physical fitness indicators are shown in Table 1. A total of 14 third-level indicators were finally selected, and the average assigned scores were all above 5 points.

Vertical jump in place and standing long jump is a traditional indicator, and easy to operate, these two indicators can reflect the synergistic strength of the athlete's ankle joints and quadriceps and lower limb muscle groups. 30 seconds squatting quality indicator is for the

action of wushu routines with the lower plate steady, up and down squatting, left and right stomping and turning of the characteristics of the movement and movement and exertion and the development of the way, because athletes often have a horse stance lunge and other walking transformation and Because athletes often have walking transitions such as horse stance lunge and fast squatting movements, most experts believe that this index can effectively reflect the athletes' lower limb strength and speed, with the quality of strength as the main and the quality of speed as the secondary. Core stability strength is a popular means of physical training in recent years, widely used, mainly to improve the body trunk control ability, because the effective completion of competitive wushu difficult movements and the athlete's ability to control the air and the ability to land stability is inseparable, so the synergy of the body trunk muscle groups to do the work and the ability to stabilize and control the body is particularly important, so the choice of the core stability training means of targeting, easy to operate the indicators. 30 meters running, ten seconds horse stance punching is the speed quality indicators, in the wushu set exercises, moving like a rabbit, fast as the wind of the sports characteristics of the athletes need to have a good short-distance starting and running speed. 400 meters and 800 meters running can reflect the athlete's endurance qualities. The horizontal fork has always been an important indicator of flexibility quality in the selection of Wushu routines, and it is also important in the selection of high-level athletes. Front and back shoulder as a flexibility quality indicators in the field of sports is widely used, joint and muscle flexibility is also the basis of human movement, athletes with good shoulder joint flexibility can make the action more stretching, the momentum is more grandiose, but also can reduce the chance of shoulder injury. 10 seconds single tap foot indicators, rotary jumping to catch the horse stance as a sensitivity indicator highlighting the swinging leg kick swing speed, because most of the difficulty of the vacating The movement emphasizes the speed of swinging leg in the air, and strives for more time for stagnation and adjustment of posture for the static movement before landing. 30-second oolong plate beating and wrist flower knife are mainly the indicators reflecting the coordination ability of the athletes.

The finalization (statistical optimization) of the indexes was done by experts, and the three levels of indexes basically reflected the physical fitness of Chinese competitive Wushu athletes.

Table 1: Weighted statistics of importance assignment for physical fitness indicators

First-level indicator	Second-level indicator	Third-level indicator	Total score assigned	Average score assigned	Sort
Physical fitness	Strength	Jump in place	468	9.36	1
		Standing long jump	454	9.08	2
		Squat for 30 seconds	342	6.84	7
		Core stability strength	296	5.92	8
	Speed	30 meter run	412	8.24	3
		10 second horse punch	258	5.16	11
	Endurance	400 meter run	366	7.32	6
		800 meter run	254	5.08	13
	Flexibility	Cross cross	406	8.12	4
		Shoulder forward and backward rotation	278	5.56	9
	Sensitive	10 seconds a single foot	394	7.88	5
		Spin jump to catch a horse step	251	5.02	14
	Coordination	30 seconds for an own goal	262	5.24	10
Wrist flower knife		256	5.12	12	

3.2 Cloud Modeling Security Risk Evaluation

3.2.1 Calculation of the evaluation criteria cloud

The evaluation of the physical fitness of competitive wushu athletes was categorized into five levels, and this division was made in conjunction with expert consultation as well as the actual situation in order to ensure that the athletes' physical fitness levels were maintained within the normal range. A standard cloud model can be generated by using the forward elicitor of the cloud model, which can be used as the basis of judgment. This standard cloud model was analyzed for overlap with a comprehensive cloud model of the athlete's physical fitness evaluation to determine the current level of the athlete. The calculated parameters of the standard cloud model are shown in Table 2, and the corresponding evaluation data value intervals for failing, poor, average, good and excellent are [0,4), [4,6), [6,7.5), [7.5,9), [9,10], and the evaluation index criteria are also distributed accordingly.

Table 2: Evaluation of standard cloud model parameters

Indicator level	Score value range	Cloud model characteristic parameters
Fail	[0,4)	(2,0.667,0.067)
Poor	[4,6)	(5,0.333,0.033)
Average	[6,7.5)	(6.75,0.25,0.025)
Good	[7.5,9)	(8.25,0.25,0.025)
Excellent	[9,10]	(9.5,0.167,0.017)

Based on the characteristic parameters of the standard cloud model, the standard cloud for physical fitness risk assessment of athletes containing five levels can be formulated. According to the characteristic parameters of the cloud model in Table 2, the MATLAB software is used to write the calculation code, and then the standard cloud diagram is drawn with the help of the forward cloud inducer, and the final standard cloud model is shown in Fig. 2. The figure visualizes the positive correlation between the evaluation value and the level of physical fitness, the lower the score value indicates the worse the physical fitness condition, and the higher the score value indicates the better the physical fitness condition.

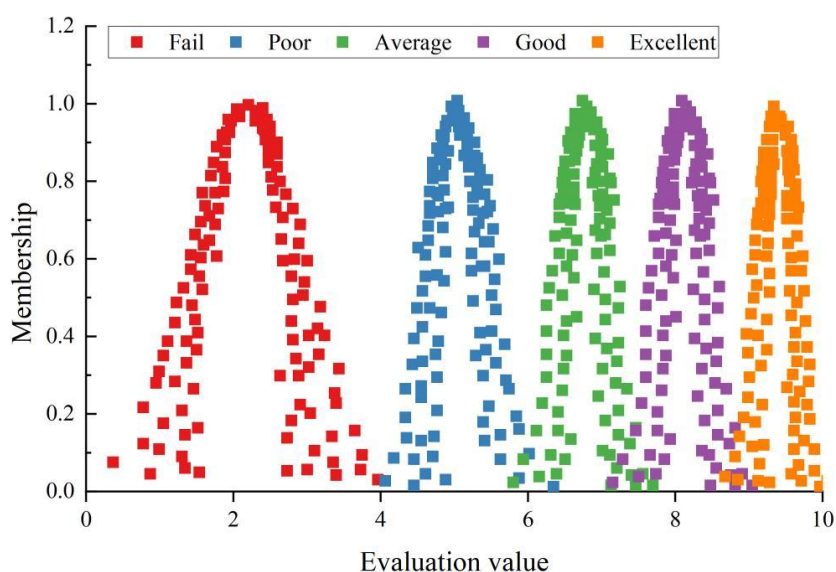


Figure 2: Standard cloud model

3.2.2 Calculation of secondary indicator cloud parameters

First of all, an evaluation grade questionnaire is to be designed for the physical quality assessment indexes of competitive wushu athletes. Then, 15 experts are invited to score the indexes with reference to the evaluation standard and the actual condition of the physical quality of competitive wushu athletes. Here, the scoring range of the experts on the evaluation level of the indicators is limited to $[0,10]$, and at the same time, the risk interval is divided according to the scores, i.e., the higher the score of the indicators, the greater the corresponding risk percentage.

On this basis, the inverse cloud inducer is used to calculate the cloud parameters of the third-level indicators, and then the second-level indicators and the final comprehensive cloud parameters are derived from this, and the final results of the cloud parameters of each indicator are shown in Table 3. After calculation, the comprehensive weights of the secondary indicators strength, speed, endurance, flexibility, sensitivity and coordination are 0.2584, 0.1727, 0.1618, 0.1391, 0.1342 and 0.1338 respectively, which shows that in the evaluation of the physical quality of the competitive wushu athletes, the evaluation of strength and speed is the focus.

Table 3: Cloud parameter results of each index

Third-level indicator	Composite weight	Index cloud parameters
Jump in place	0.0668	(4.86,0.98,0.16)
Standing long jump	0.0626	(5.32,1.02,0.13)
Squat for 30 seconds	0.0612	(4.11,0.89,0.15)
Core stability strength	0.0678	(4.78,0.92,0.18)
30 meter run	0.0852	(5.16,0.98,0.17)
10 second horse punch	0.0875	(5.24,1.05,0.18)
400 meter run	0.0795	(4.67,0.95,0.19)
800 meter run	0.0823	(5.04,0.98,0.14)
Cross cross	0.0726	(5.22,0.95,0.15)
Shoulder forward and backward rotation	0.0665	(4.95,1.04,0.15)
10 seconds a single foot	0.0727	(5.02,1.02,0.18)
Spin jump to catch a horse step	0.0615	(4.98,1.02,0.15)
30 seconds for an own goal	0.0616	(5.38,1.12,0.16)
Wrist flower knife	0.0722	(4.53,1.05,0.12)

3.2.3 Cloud Model Evaluation Results and Interpretation Analysis

Through Matlab to generate the risk evaluation cloud of secondary indicators, to judge the evaluation interval of the six dimensions of strength, speed, endurance, flexibility, sensitivity and coordination, the results of the comparison of the evaluation cloud model of secondary indicators are shown in Figure 3. Strength cloud $E_x = 6.5, E_n = 0.283$, falls between “average” and ‘good’, close to “average”, concentrated and stable. Speed cloud $E_x = 8.1, E_n = 0.227$, close to “good”. Endurance cloud $E_x = 7.6, E_n = 0.268$, at the upper end of “fair”, close to “good”, with large dispersion. Flexibility cloud $E_x = 5.8, E_n = 0.324$, between “poor” and “fair”, with large dispersion. Sensitive cloud $E_x = 7.0, E_n = 0.242$, in the middle of “fair”. Coordinated cloud $E_x = 7.2, E_n = 0.235$, also in the upper “fair” range. E_e , all < 0.05 , stable cloud shape, reliable evaluation.

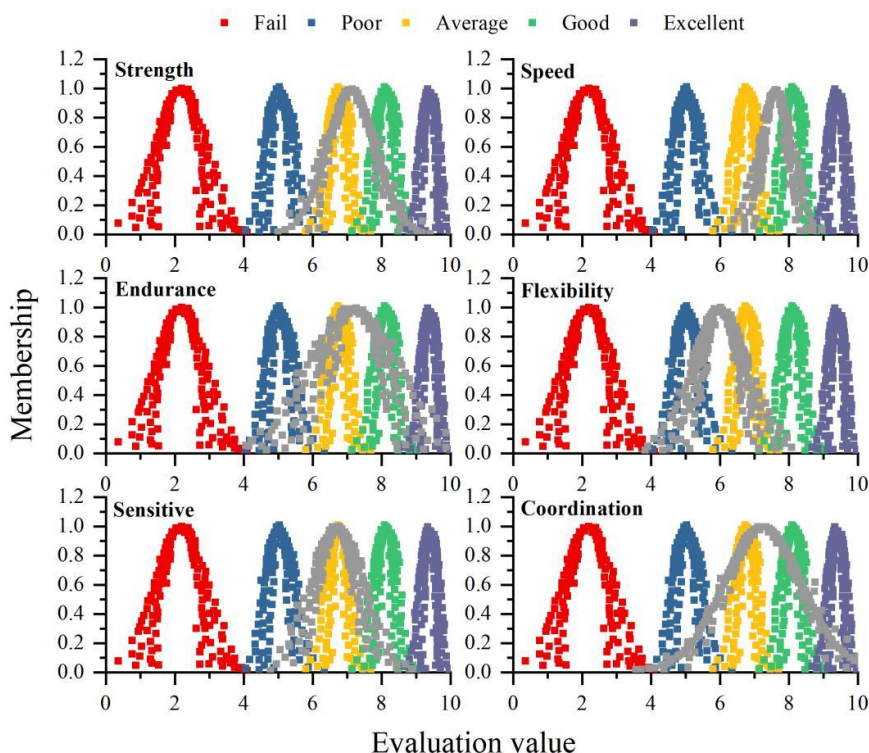


Figure 3: Comparison results of cloud models evaluated by secondary indicators

Using the resulting weight cloud model to weighted average operation on the affiliation cloud model, the fuzzy comprehensive evaluation results cloud model is obtained as shown in Figure 4. Where $E_x = 7.7, E_n = 0.311, H_e = 0.02$, the randomness is large, the degree of discrete is high, and the distribution of evaluation results is relatively decentralized. As can be seen in Figure 5, the physical quality evaluation values of the members of the martial arts team are basically in the range of [6,9], i.e., the level of comprehensive physical quality of the members of the martial arts team is in the range between “average” and “good”.

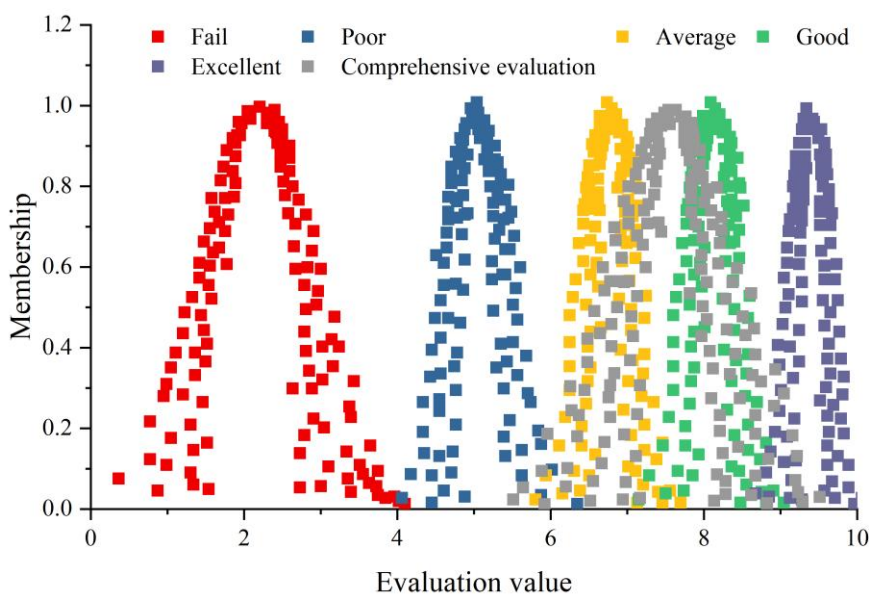


Figure 4: Cloud model of fuzzy comprehensive evaluation results

The final distribution of the degree of certainty of the evaluation value obtained is shown in Figure 5. From the figure, it can be seen that when the state cloud droplets in the evaluation network system increase rapidly, the core cloud droplets appear in the place where the certainty degree is 0.8~1, and most of the indicators are concentrated, which indicates that the evaluation results are credible.

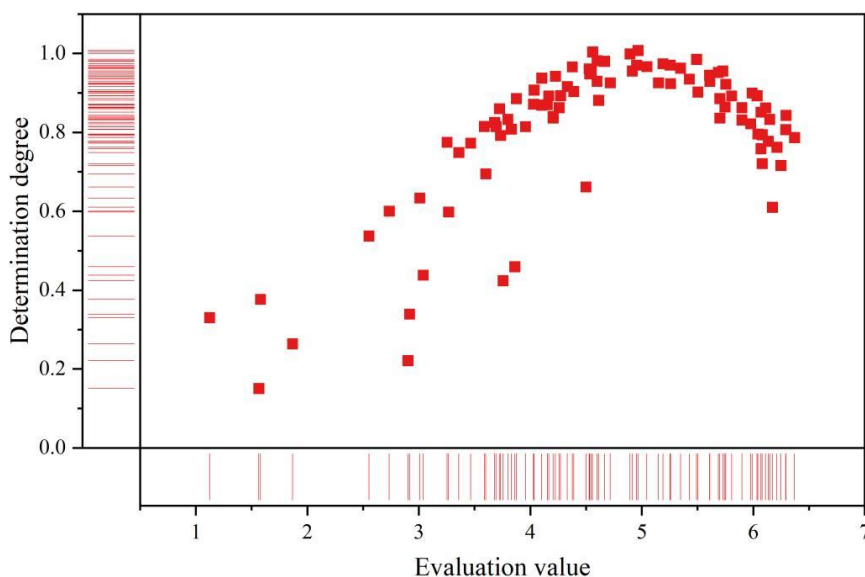


Figure 5: Evaluation value determination

4 Conclusion

Based on the idea of fuzzy neutral information, this paper incorporates the uncertainty and transition state in the evaluation of physical quality of competitive wushu athletes into the modeling process, and designs a fuzzy comprehensive cloud evaluation method for physical quality of competitive wushu athletes. Combined with specific data, diagnosis is made for the athlete's physical quality development level.

(1) Fourteen physical quality test indicators for competitive wushu athletes were identified through the screening process, namely, in situ vertical jump, standing long jump, 30-second squat, core stability strength, 30-meter run, ten-second horse stance punch, 400-meter run, 800-meter run, horizontal fork, forward and backward shoulder turn, 10-second single-tap foot indicator, spinning jump to catch horse stance, 30-second udon discus punch, and wrist flower knife.

(2) Through the three-level indicator cloud parameter model, it can be concluded that the strength (0.2584) and speed (0.1727) indicators have the highest weights, indicating the importance of strength and speed qualities for competitive wushu.

(3) In the empirical analysis, the E_x values of the secondary indicators, namely strength, speed, endurance, flexibility, agility and coordination, were 6.5, 8.1, 7.6, 5.8, 7.0 and 7.2 respectively, and E_e was all <0.05 . The comprehensive evaluation result E_x reached 7.9, falling between "average" and "good", close to "good".

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References

- [1] Theeboom, M., Zhu, D., & Vertonghen, J. (2017). ‘Wushu belongs to the world’. But the gold goes to China...: the international development of the Chinese martial arts. *International review for the sociology of sport*, 52(1), 3-23.
- [2] Moenig, U., Kim, M., & Choi, H. M. (2023). Traditional martial arts versus martial sports: the philosophical and historical academic discourse. *Revista de Artes Marciales Asiáticas*, 18(1), 41-58.
- [3] Han, Q. S., Theeboom, M., & Zhu, D. (2021). Chinese martial arts and the olympics: analysing the policy of the international wushu federation. *International review for the sociology of sport*, 56(5), 603-624.
- [4] Cynarski, W. J., Yu, J. H., & Pawelec, P. (2017). Changes in the level of physical fitness on the way to mastery in martial arts according to activity. *Ido Movement for Culture. Journal of Martial Arts Anthropology*, 17(1), 38-44.
- [5] Ivanovna, P. V., Andreevich, S. D., Germanovna, K. Y., Anatolyevna, B. N., Vitalyevich, L. J., & Aleksandrovich, S. A. (2017). Psychophysiological determinants of successful training and competitive activity of martial artists. *Journal of Pharmaceutical Sciences and Research*, 9(10), 1792-1796.
- [6] Origua Rios, S., Marks, J., Estevan, I., & Barnett, L. M. (2018). Health benefits of hard martial arts in adults: a systematic review. *Journal of sports sciences*, 36(14), 1614-1622.
- [7] Koutures, C., & Demorest, R. A. (2018). Participation and injury in martial arts. *Current sports medicine reports*, 17(12), 433-438.
- [8] Spanias, C., Nikolaidis, P. T., Rosemann, T., & Knechtle, B. (2019). Anthropometric and physiological profile of mixed martial art athletes: A brief review. *Sports*, 7(6), 146.
- [9] Wan, H. (2023). Improvement of physical fitness by the martial arts training program. *Revista Brasileira de Medicina do Esporte*, 29, e2022_0646.
- [10] Simanjuntak, V., Rahayu, T., & Yudhistira, D. (2022). Analysis of body mass index and physical condition of martial athletes in West Kalimantan Province: Study towards PON 2021. *International Journal of Human Movement and Sports Sciences*, 10(4), 768-774.
- [11] Volodchenko, O., Podrigalo, L., Aghyppo, O., Romanenko, V., & Rovnaya, O. (2017). Comparative Analysis of a functional state of martial arts athletes. *Journal of Physical Education and Sport*, 17(3), 2142-2147.
- [12] Katamanova, E., Vasilieva, L., Kuptsova, N., Kodinets, I., Kudaeva, I., & Sal’nikova, G. (2020). Comprehensive assessment of the health and physical development in martial arts athletes. In *E3S Web of Conferences* (Vol. 210, p. 17002). EDP Sciences.
- [13] Nurhidayah, D., Prasetyo, Y., Sutapa, P., Nanda, F. A., Mustafa, P. S., Astuti, D., & MT,

- A. D. N. K. (2024). Validity and reliability of the physical fitness test instrument for retired martial art athletes. *Pedagogy of Physical Culture and Sports*, 28(5), 387-395.
- [14] Li, L. (2019). Research on Evaluation Index and Index System of Athletes' Physical Fitness Training Based on Data Mining. In 3rd International Conference on Economics, Management Engineering and Education Technology (ICEMEET 2019) (pp. 1153-1157).
- [15] Li, J. (2021). EVALUATION METHOD OF ATHLETES'SPECIAL PHYSICAL FITNESS BASED ON INTERNET OF THINGS. *Revista Brasileira de Medicina do Esporte*, 27, 62-65.
- [16] Henriques-Neto, D., Minderico, C., Peralta, M., Marques, A., & Sardinha, L. B. (2020). Test–retest reliability of physical fitness tests among young athletes: The FITescola® battery. *Clinical Physiology and Functional Imaging*, 40(3), 173-182.