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Research and application of influencing factors on students' physical health based on fuzzy evaluation model

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ABSTRACT

Physical fitness refers to the basic ability of human muscle activity, and is a comprehensive reflection of the human organ system's function in the muscle work. It includes speed quality, endurance quality, sensitive quality, flexibility quality, etc. In order to better distinguish the pros and cons of each person's physical quality, this paper uses fuzzy mathematics method to conduct comprehensive evaluation on physical fitness of college students. First, it constructs the basic idea of fuzzy comprehensive evaluation by using the maximum membership degree (reviews) and the principle of fuzzy linear transformation, and consider the impacts of a variety of factors related to the evaluated things in order to make a more reasonable and comprehensive evaluation to another thing with certain purpose; In addition this paper undertakes a comprehensive evaluation on a person as well as everyone of a class, in order to achieve the specific application of the fuzzy mathematics' evaluation model on "physical health".

KEYWORDS

Students;
Physical fitness;
Fuzzy evaluation;
Influence factors;
Weight analysis.

INTRODUCTION

Student's physical fitness is an important part of the national physique, and related areas of the world attach great importance; in the Charter that made a long time ago by the World Health Organization, the definition of physical fitness refers to the comprehensive reflection of the human organ system's function in the muscle work, and is the basic capacity of human muscle activity. Physical fitness generally includes flexibility, speed, agility, strength, endurance, etc. The physical fitness is often potentially manifested in people's learning and work life, but also naturally reflected in terms of physical exercise. The quality of a person's physical fitness is related with the genetic, but is more close to the acquired nutrition and physical activity, the right approach and proper exercise can improve the physical fitness levels from all aspects. In order to strengthen the research on the comprehensive evaluation of students' physical fitness, a lot of people establish a scientific, representative, practical and operable index system, which provides simple and reliable comprehensive evaluation method, has a very important practical significance on the scientific evaluation of student's physical health,

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promoting scientific and effective exercise of college students, forming a good exercise habit and promoting the reform of school's physical education.

For the research of physical fitness many people have made efforts and achieved results, which provides favorable conditions on its research for scholars of different social sectors and provides the impetus for the development of people's health. For example: Huiping and Zhu Hongwei conducted a study on the physical fitness of the United States, the text showed the test of the dozens of morphological indicators. The "Physical test standards" is the uniform requirement to evaluate the physical fitness, and implemented universally in the country. Apart from this, this article points out that the country guide people to enhance physical fitness and scientific fitness by studying the physical fitness. Recently, the health fitness testing methods commonly used in the United States is more popular, the indicators that a company selected are all relevant to human health, which can be divided into body composition; body flexibility; cardiopulmonary function; muscle strength and endurance; ② Lin Jing, Wong Kin-hung wrote about the research of physical quality in Japan; the article pointed out that Japan also attach great importance to constitution research and form a more rational system; the article studies the constitution from the mental state constitution, morphogenesis and function assessment three aspects. In aspects of morphological development, we should focus on conventional anthropometric and test of the body composition, body size and bone development; in these areas it has formed a more systematic and standardized national institution; in aspect of function assessment, we should place emphasis on lung function; in aspect of physical power measurement, it includes the relationship between the physical power and ability of athletes and workers, climatic, the influences of climate and environment on physical power, follow-up observation of physical development, and the impact of exercise on physical and mental development of young people, etc. ; ③ Larry D. John Adams Lee scholars believe that physical fitness should include two aspects of test and assessment, the greater purpose is to assess the degree of physical development or improvement, for which the authors have developed a more reasonable training programs of teaching assessment, reasonable exercise prescription, and provide the necessary basis for the constitution prediction and classification. Therefore developed countries have gradually established a relatively complete comprehensive evaluation system of physical fitness. On the research methods of the "weight", we also propose "analytic hierarchy process", and the method currently has become an important way to determine the factor weight.

Based on the results of previous studies, this paper analyzes the influence factors of physical fitness, discusses the algorithm of fuzzy mathematics, provides a theoretical basis for it, and at the same time verifies the rationality and effectiveness of the model through two practical experiences.

COMPREHENSIVE EVALUATION MODEL OF FUZZY MATHEMATICS

Physical fitness of students is affected by a variety of factors, but these factors have ambiguity and uncertainty; it is difficult to make the evaluation the application of the previous method, we propose comprehensive evaluation model of fuzzy mathematics in order to more rationally establish a comprehensive evaluation system of the student's physical fitness. The correlation theory of the model is the basic idea that constructs fuzzy comprehensive evaluation by using the principle of the maximum membership degree (reviews) and fuzzy linear transformation; in very ambiguity situation, we consider the impact of a variety of factors that related to the evaluated things, in order to achieve another more reasonable comprehensive evaluation method for another thing. It makes comprehensive evaluation methods and procedures by using fuzzy mathematics:

First, we should determine the object to be evaluated, it is affected by n variable factors, and the factors set is u , as defined below:

$$\mathbf{u = (u_1, u_2, u_3, \cdots, u_n)} \quad \textbf{(1)}$$

And stipulate $u_i\ (i = 1,2,3,\cdots,n)$

Since the weight of each variable is not the same, the impact degree is also not the same for the determined evaluation level, we have assumed that the weight distribution is a_i and:

$$\mathbf{a_i = (a_1, a_2, a_3, \cdots a_n)} \quad \textbf{(2)}$$

Wherein $a_i\ (i = 1,2,3,\cdots,n)$ is the weight value of for-

mula (2) and we know $a_i \geq 0$ and $\sum_{i=1}^{n} a_i = 1$ based on common sense.

If each factor a_i also contains m sub-factors, the factor set is:

$$\mathbf{u_i = (u_{i,1}, u_{i,2}, u_{i,3}, \cdots, u_{i,m})} \quad (3)$$

The corresponding weight value is:

$$\mathbf{a_i = (a_{i,1}, a_{i,2}, a_{i,3}, \cdots a_{i,m})} \quad (4)$$

For the weights a_i of $u_{i,j}$, according to common sense $a_{i,j} \geq 0$ and $\sum_{j=1}^{m} a_{i,j} = 1$, we build an indicator set of the evaluation:

$$\mathbf{v = (v_1, v_{2,3}, \cdots, v_s)} \quad (5)$$

The corresponding evaluation objects can be divided into s different levels, here we suppose $v_1, v_2, v_3, \cdots, v_s$ is the evaluation degree of pros and cons from high to low, such as excellent, good, pass, fail and so on.

Before the establishment of fuzzy comprehensive evaluation model of factors u_i, we should determine the evaluation degree of each factor $u_{i,j}$, for the evaluation of the evaluation index set v and the fuzzy comprehensive evaluation of $r_i = (a_{i,1}, a_{i,2}, a_{i,3}, \cdots a_{i,m}) * (r_{i,1})^T, i = 1,2,3, \cdots n$, we suppose the factor as $u_{i,j}(j = 1,2,3, \cdots, m)$.

We obtain the comprehensive assessment results after the synthesis operator of the fuzzy matrix, namely:

$$\mathbf{b = a * r = (a_1, a_2, a_3, \cdots a_n) * (r_1, r_2, r_3, \cdots, r_n)^T = (b_1, b_2, b_3, \cdots, b_n)} \quad (6)$$

For the judgment of fuzzy comprehensive evaluation, we use the maximum rating method to get a definitive assessment level from the fuzzy sets b. Because $B_k = \{B_I\}$, the evaluation grade of the final results of B_K is k.

EVALUATION MODEL OF STUDENTS' PHYSICAL FITNESS BASED ON THE COMPREHENSIVE EVALUATION OF FUZZY MATHEMATICS

Based on the principle of fuzzy comprehensive evaluation, as well as the principle of objective evaluation, this paper creates a fuzzy comprehensive evaluation model on the student's physical fitness according to the theory mentioned above, the weight of the related factors is:

$$\mathbf{a = (a_1, a_2, a_3) = (0.1, 0.3, 0.6)} \quad (7)$$

The affecting factor sets are:

$$u = (u_1, u_2, u_3) = \{\text{Body shape , somatic function , Exercise quality}\} \quad (8)$$

Due to the involved variables is relatively more, we divide each factor into several sub-factor, and its corresponding

$$u_1 = (u_{1,1}) = \{\text{Height standard weight}\} \quad (9)$$

The corresponding weight value is: $a_1 = (a_{1,1}) = 1$

$$u_2 = (u_{2,1}, u_{2,2}) = \{\text{Vital capacity index weight , Step test index}\}, \quad (10)$$

The corresponding weight value is $a_2 = (a_{2,1}, a_{2,2}) = (0.6, 0.4)$;

$u_3 = (u_{3,1} u_{3,2}, u_{3,3}, u_{3,4}, u_{3,5}) = \{$ 50 m run (speed), standing long jump (the strength of lower extremity), sit and reach (flexibility), power BMI (the strength of upper body), 1,000 m (800 m) run (endurance) $\}$, and the corresponding weight value is:

$$\mathbf{a_3 = (a_{3,1}, a_{3,2}, a_{3,3}, a_{3,4}, a_{3,5}) = (0.25, 0.15, 0.25, 0.25, 0.1)} \quad (11)$$

Based on the above theory, we can establish the indicator sets of the evaluation:

$$\mathbf{v = (v_1, v_2, v_3, v_4) =}$$

$$\mathbf{\text{Excellent, good, pass, fail}\ \}} \quad (12)$$

Suppose the fail is 0-0.59, pass is 0.60-0.75, good is 0.76-0.85, and excellent is 0.86-1.

Establishing a fuzzy mathematics comprehensive evaluation of the factors u_i to determine the evaluation degree of each sub-factor $u_{i,j}$ on the evaluation index,

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and conduct fuzzy evaluation process for the evaluation degree level of corresponding different achievement segments; Here we only study the determination on the evaluation degree of standard weight and height. We know the standard to measure a student's body shape is height and weight, as shown in TABLE 1; the often used formula in the international area is:

$$\text{Standard weight} = [\text{Measuring weight} - (\text{height} - 100) * 0.9] / [(\text{height} - 100) * 0.9] * 100\% \quad (13)$$

To get a comprehensive evaluation of the students' physical fitness, it is necessary to calculate the fuzzy math matrix synthesis, determine the evaluation grade of the students based on the best evaluation degree.

TABLE 1: Evaluation tables of the height and standard weight

Performance segment	the evaluation degree $r_{1,1}$			
	fail	pass	good	excellent
Between 0% and 5%	0	0	02.5	0.75
Less than (more than) 6% -20%	0.25	0.50	0.25	0
Less than (more than) 20%	1	0	0	0

MODEL VALIDATIONS

The test model of single individual

According to the above model, this paper surveys the physical condition of the school's students, as shown in TABLE 2[7]:

By comparing with the TABLE 2 and relevant information derive the evaluation degrees of the factors, as shown in TABLE 3.

Therefore, the comprehensive evaluation criteria of body shape u_1 for the student is:

TABLE 2 : Student's physical condition

Test Project	Achievement
Sit and Reach	7.5
1000m run	3.74 seconds
50m run	7.3
Standing long jump	243
Grip strength and body mass index (BMI)	63
Step test index	51
Vital capacity and body mass index (BMI)	67
Standard body mass index (BMI)	3%

TABLE 3 : Evaluation degree of the project

Test Project	$r_{i,j}$			
Sit and Reach	0	0.125	0.75	0.125
1000m run	0.125	0.75	0.125	0
50m run	0.125	0.625	0.25	0
Standing long jump	0.25	0.625	0.125	0
Grip strength and body mass index (BMI)	0	0.75	0.25	0
Step test index	0.125	0.75	0.125	0
Vital capacity and body mass index (BMI)	0.125	0.75	0.125	0
Standard body mass index (BMI)	0.75	0.25	0	0

$$\begin{aligned} r_1 &= (1) * (0.75 \quad 0.25 \quad 0 \quad 0) \\ &= (0\,0.75 \quad 0.25 \quad 0 \quad 0) \end{aligned} \quad (14)$$

The evaluated value of r_1 is: fail 0, pass 0, good 0.25 and excellent 0.75. Subsequently the evaluated value of u_2 is:

$$\begin{aligned} r_2 &= (0.6 \quad 0.4) * \begin{pmatrix} 0.125 & 0.75 & 0.125 & 0 \\ 0.125 & 0.75 & 0.125 & 0 \end{pmatrix} \\ &= (0.125 \quad 0.75 \quad 0.125 \quad 0) \end{aligned} \quad (15)$$

The evaluated value of u_3 is:

$$\begin{aligned} r_3 &= (0.25 \quad 0.15 \quad 0.25 \quad 0.25 \quad 0.1) * \begin{pmatrix} 0 & 0.75 & 0.25 & 0 \\ 0.25 & 0.625 & 0.125 & 0 \\ 0.125 & 0.625 & 0.25 & 0 \\ 0.125 & 0.75 & 0.125 & 0 \\ 0 & 0.125 & 0.75 & 0.125 \end{pmatrix} \\ &= (0.1 \quad 0.6375 \quad 0.25 \quad 0.0125) \end{aligned} \quad (16)$$

Thus the comprehensive evaluation of the student's body is:

$$\begin{aligned} b &= a * (r_1 \quad r_2 \quad r_3)^T \\ &= (0.1 \quad 0.3 \quad 0.6) * \begin{pmatrix} 0.75 & 0.25 & 0 & 0 \\ 0.125 & 0.75 & 0.125 & 0.125 \\ 0.1 & 0.6375 & 0.25 & 0.0125 \end{pmatrix} \\ &= (0.1725 \quad 0.6325 \quad 0.1875 \quad 0.0075) \end{aligned} \quad (17)$$

We can know that the comprehensive evaluation grade of the students is, such as: fail 0.0075, pass 0.1875, good 0.6325 and excellent 0.1725. Based on the principle of the maximum evaluation value, we take the good 0.6325 as the students' comprehensive evaluation results; therefore the student's physical fitness is good.

Test model of multiple individual

After a lot of information we draw the mutual relationship between the physical quality, health, function and form, and we use the AHP method to construct the matrix. The judgment of the first index layer is p, the judgment of the second layer is p_i (i=1,2,3), and solve the eigenvector through related software, obtain the weight value a through the consistency test, therefore the weight value of the evaluation index is a_1, a_2, a_3.

$$\mathbf{a_1} = (0.5247 \quad 0.3338 \quad 0.1415)$$

$$\mathbf{a_2} = (0.25 \quad 0.75)$$

$$\mathbf{a_3} = (0.6667 \quad 0.3333)$$

We summarize the weights obtained in accordance with the results, and construct the system with secondary indicators on this basis, as shown in TABLE 4:

As shown in the detection one a student's physical fitness is divided into four grades: fail, pass, good and excellent four evaluation grade sets.

We conduct test on the physical fitness of 23 students for a class, and obtain the evaluation matrix of fuzzy mathematics through related software process:

$$\mathbf{r_{11}} = \begin{pmatrix} 0.4 & 0.3 & 0.3 & 0 \\ 0.6 & 0.2 & 0.1 & 0.1 \\ 0.3 & 0.2 & 0.4 & 0.1 \end{pmatrix} \tag{18}$$

$$\mathbf{r_{22}} = \begin{pmatrix} 0.6 & 0.3 & 0.1 & 0 \\ 0.4 & 0.3 & 0.2 & 0.1 \\ 0.3 & 0.3 & 0.3 & 0.1 \end{pmatrix} \tag{19}$$

$$\mathbf{r_{11}} = \begin{pmatrix} 0.4 & 0.3 & 0.2 & 0 \\ 0.3 & 0.5 & 0.1 & 0 \\ 0.4 & 0.2 & 0.3 & 0.1 \end{pmatrix} \tag{20}$$

Thus the comprehensive evaluation of the student's body is about:

$$\mathbf{r_1} = \mathbf{a_1} * \mathbf{r_{11}} = (0.164 \quad 0.539 \quad 0.297)\begin{pmatrix} 0.4 & 0.3 & 0.3 & 0 \\ 0.6 & 0.2 & 0.1 & 0.1 \\ 0.3 & 0.2 & 0.4 & 0.1 \end{pmatrix} = (0.478 \quad 0.216 \quad 0.222 \quad 0.084) \tag{21}$$

$$\mathbf{r_2} = \mathbf{a_2} * \mathbf{r_{22}} = (0.722 \quad 0.174 \quad 0.103)\begin{pmatrix} 0.6 & 0.3 & 0.1 & 0 \\ 0.4 & 0.3 & 0.2 & 0.1 \\ 0.3 & 0.3 & 0.3 & 0.1 \end{pmatrix} = (0.478 \quad 0.216 \quad 0.222 \quad 0.084) \tag{22}$$

TABLE 4 : Quantitative assessment system of students' quality

Criterion layer b	Weights	Index layer c	Relative weights a
		Financial situation u_{11}	0.1638
Body shape u_1	0.5247	Get access to information u_{12}	0.5390
		Time to the medical institutions u_{13}	0.2973
		Medical expense situation u_{21}	0.7225
Physical function u_2	0.3338	The total number of medical staff u_{22}	0.1741
		The proportion of ordinary and experts u_{23}	0.1033
		Government expenditures u_{31}	0.3092
Physical fitness u_3	0.1415	Coverage of basic medical insurance u_{32}	0.5813
		Government health supervision u_{33}	0.1096

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$$r_3 = a_{31} * r_{33} = (0.309 \quad 0.581 \quad 0.109)\begin{pmatrix} 0.4 & 0.3 & 0.2 & 0 \\ 0.3 & 0.5 & 0.1 & 0 \\ 0.4 & 0.2 & 0.3 & 0.1 \end{pmatrix} \quad (23)$$

$$= (0.342 \quad 0.405 \quad 0.153 \quad 0.01)$$

Through the above conditions, construct a matrix of total evaluation set:

$$r = \begin{pmatrix} r_1 \\ r_2 \\ r_3 \end{pmatrix} = \begin{pmatrix} 0.478 & 0.216 & 0.222 & 0.084 \\ 0.534 & 0.300 & 0.138 & 0.028 \\ 0.312 & 0.405 & 0.153 & 0.11 \end{pmatrix} \quad (24)$$

So the overall evaluation calculation is:

$$b = a * r = (0.122 \quad 0.648 \quad 0.230)\begin{pmatrix} 0.478 & 0.216 & 0.222 & 0.084 \\ 0.534 & 0.300 & 0.138 & 0.028 \\ 0.342 & 0.405 & 0.153 & 0.011 \end{pmatrix} \quad (25)$$

$$= (0.210 \quad 0.403 \quad 0.202 \quad 0.235)$$

The comprehensive evaluation grade of the students in the class through the above operation is: fail 0.210, pass 0.403, good 0.202 and excellence 0.235. According to the maximum evaluation principle, we take the pass value 0.403 as comprehensive evaluations of the students in this class, and therefore explain the physical fitness of the students in this class.

CONCLUSIONS

Through the establishment of comprehensive evaluation model based on fuzzy mathematics, the evaluation model on students' physical fitness proves the merits of the students' physical fitness only by the evaluating degree. The test model of single individual proves that the chosen student's physical fitness is good, and the test model of multi-individuals verifies the physical quality of students in this class is poor. Through the above we know that in the future we should develop good habits, maintain a positive and optimistic attitude, strengthen the sport education, and attract students to participate in physical activity in terms of education in order to improve students' overall physical fitness.

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