

The Research of Fuzzy Comprehensive Evaluation Method and the Impact Analysis for Body Function When Exercising

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Abstract. Table tennis is very common in our country, Generally believe that Table tennis can improve body function, But the exact extent of the impact is still no concrete research, In this study, using the fuzzy comprehensive evaluation method , Established the Fuzzy mathematical model of the Table tennis affect body function, The weight of A, B, C, D four Evaluation Level respectively are 0.489,0.444,0.067, and 0.000. Get the score of the Table tennis affect bodily functions is 91.33 through the evaluation of 30 people, the results is satisfying to judge the physical function with this model, this illustrate Table Tennis has a good improvement of physical function and can extensively carried out used as a good fitness among the masses.

Introduction

Table tennis is known as China's national ball, the facilities and equipment are relatively simple of this sport. With the strong interesting And of all ages, of all genders can participate in this sport , Therefore, the table tennis sport by the favorite of the masses in our country. Some studies have shown that if do exercise with table tennis for a long time can significantly improve bodily functions and play a fitness effect obviously. Except table tennis, basketball, football, badminton, volleyball and other sports also been widely carried out, All have good mass foundation, simultaneously these movements can be used as a daily exercise, can play a good effect to improve the body function. In this study, we established the model of body function evaluation, analysis the impact of table tennis for body function using the method of fuzzy mathematics.

Introduction of fuzzy mathematical evaluation methods

Assumed there are m factors affect the results of evaluation, the composition factors set denoted as $U = \{u_1, u_2, \dots, u_m\}$, the final results of the evaluation contains n types, evaluation set denoted as $V = \{v_1, v_2, \dots, v_n\}$. Firstly, to judge the i single factor $u_i (i=1,2,\dots,m)$ of U on the judge set

$v_i (i=1,2,\dots,m)$, single factor evaluation set of u_i denoted as $r_i = (r_{i1}, r_{i2}, \dots, r_{in})$ where $\sum_{j=1}^n r_{ij} = 1$.

Evaluation of each single factor is composed of a total evaluation matrix, denoted as R .

$$R = \begin{pmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{pmatrix}$$

$r_{ij} = u_R(u_i, v_j)$ is the degree of membership of the single factor u_i for the level judge v_j .

When conduct single factor judgment, the results are easier to obtain .For instance, all the experts to evaluate for an influence factors, the results are divided into four grades of A, B, C, D

The number of each level respectively 20,15,5,0, the judgment of this factors are (0.5,0.375,0.125,0). That is the corresponding value of the number of each class dividing the total.

When taking into account multiple factors, need to use $\tilde{A}$, it represent fuzzy subset of factors

importance, calculation formula is
$$\tilde{A} = \frac{a_1}{u_1} + \frac{a_2}{u_2} + \dots + \frac{a_m}{u_m} = \sum_{i=1}^m \frac{a_i}{u_i}$$

a_i represents the membership of u_i for $\tilde{A}$, Also can be used $u_{\tilde{A}}(u_i)$ to represent, " $\sum$ " indicates a whole that fuzzy subset on the domain, the significance of a_i is the degree of impact which single factor u_i for the total evaluation, can also reflect the ability of u_i .

For fuzzy subset $\tilde{A}$, we can use the Delphi method to determine, the basic steps are as follows:

1) To determine the importance sequence value of each factor

All appraiser to judge for each factors, F_i of each factor are given, F_i is a number from 1 to m , the value of F_i is 1 when the degree of importance of the factors is the most important, the value of F_i is m when the degree of importance of the factors is minimum.

F_{i-k} Indicate the sequence value of K-th appraiser for u_i , shown in table 1.

TABLE I. THE F_i VALUE ASSESSMENT TABLE OF K

Factors sequence number	u_1	u_2	$\dots$	u_m
The importance sequence values F_{i-k}	$F_{1\ k}$	$F_{2\ k}$	$\dots$	$F_{m\ k}$

2) Prepared the priority score table

According to importance sequence value of the factors provided by the evaluators, analysis carried out as follows: When $\frac{F_{j\ k}}{F_{i\ k}} > 1$, $A_{ij\ k} = 1$; when $\frac{F_{j\ k}}{F_{i\ k}} < 1$, $A_{ij\ k} = 0$.

Assumed there is n appraisers, Add together the $A_{ij\ k}$ values of each evaluators, obtain

$$A_{ij} = \sum_{k=1}^n A_{ij\ k}, i = 1, 2, \dots, m; j = 1, 2, \dots, m$$

The statistical values of $m \times m$ composited the priority score table, as shown in Table 2.

TABLE II. PRIORITY SCORE TABLE

Factors sequence number	u_1	u_2	$\dots$	u_m
u_1	A11	A12	$\dots$	A1m
u_2	A21	A22	$\dots$	A2m
$\vdots$			$\vdots$	
u_m	Am1	Am2	$\dots$	Amm

3) Calculate

Respectively adding the A_{ij} value of each row of the table 2, the result is

$$\Sigma A_i = \sum_{j=1}^m A_{ij}, i = 1, 2, \dots, m$$

ΣA_i is the sum of A_{ij} in i-th row, let

$$\Sigma A_{\max} = \max\{\Sigma A_1, \Sigma A_2, \dots, \Sigma A_m\} \quad \Sigma A_{\min} = \min\{\Sigma A_1, \Sigma A_2, \dots, \Sigma A_m\}$$

So degree of importance of $\Sigma A_{\max}$ is the largest, the degree of importance of $\Sigma A_{\min}$ is the smallest.

4) Calculate the differential

Let $a_{\max} = 1, a_{\min} = 0.1$ ($a_{\max}, a_{\min}$ are the any value of [0,1]) then the differential

$$d = \frac{\Sigma A_{\max} - \Sigma A_{\min}}{a_{\max} - a_{\min}}$$

5) To determine the importance coefficients of each factor

a_i is the importance coefficient of each factor, the calculation method is as follows

$$a_i = \frac{\Sigma A_i - \Sigma A_{\min}}{d} + 0.1 \quad i = 1, 2, \dots, m$$

Then obtain the fuzzy subset $\tilde{A} = (a_1, a_2, \dots, a_m)$

Obtained fuzzy set $\tilde{A}$ and fuzzy evaluation matrix $\tilde{R}$, get the evaluation results by the fuzzy matrix synthetic arithmetic $\tilde{B} = \tilde{A} \circ \tilde{R} = (b_1, b_2, \dots, b_n)$

Where “ $\circ$ ” is the synthetic arithmetic, $\tilde{B}$ is the level fuzzy subset, b_j is the membership of v_j for $\tilde{B}$.

The establishment of the evaluation model of body functions

The effect of Table tennis for bodily functions mainly is heart rate, lung capacity and physical fitness, this study identified this three factors as the influence factor, In order to get the fuzzy vector $\tilde{A}$, Using the questionnaire method get 30 parts of data, shown in Table 3.

TABLE III. THE QUESTIONNAIRE RESULTS OF THE 30 PARTS

i	heart rate	lung capacity	physical fitness	i	heart rate	lung capacity	physical fitness
1	1	2	3	16	3	2	1
2	2	1	3	17	1	3	2
3	2	3	1	18	3	2	1
4	1	3	2	19	2	3	1
5	1	2	3	20	2	1	3
6	2	1	3	21	3	1	2
7	3	2	1	22	2	1	3
8	2	3	1	23	2	3	1
9	3	1	2	24	1	3	2
10	1	3	2	25	1	2	3
11	2	3	1	26	2	3	1
12	1	2	3	27	2	1	3
13	1	3	2	28	3	1	2
14	2	3	1	29	3	2	1
15	2	1	3	30	1	2	3

The leftmost row indicated the number of the questionnaire, the later three numbers indicated the importance of indicators rank, "1" for the maximum degree of importance, "3" for the minimum degree of importance.

Take the first questionnaire for example, the Judgment of the second question is 2, that is $F_{2\ 1} = 2$, the Judgment of the third question is 3, so $F_{3\ 1} = 3$, then $\frac{F_{2\ 1}}{F_{3\ 1}} = \frac{2}{3} < 1$, recorded as $A_{32\ 1} = 0$, On the contrary, $\frac{F_{3\ 1}}{F_{2\ 1}} = \frac{3}{2} > 1$, then $A_{23\ 1} = 1$. Therefore, get the priority score table according to the results of Table 3, shown as Table 4.

TABLE IV. THE PRIORITY SCORE TABLE 1

0	1	1
0	0	1
0	0	0

The table 4 is the priority score table of first questionnaire, similarly, Each questionnaire can get a priority score table, Add the same items in all priority score tables, obtain the priority score table as following, shown as Table 5.

TABLE V. THE PRIORITY SCORE TABLE 2

indicators	heart rate	lung capacity	Physical fitness	ΣA_i	a_i
u_1	—	25	18	43	1.000
u_2	20	—	14	34	0.460
u_3	18	10	—	28	0.100

Seen from Table 5 $\Sigma A_{\max} = 43$, $\Sigma A_{\min} = 28$, then calculated the differential

$$d = \frac{\Sigma A_{\max} - \Sigma A_{\min}}{a_{\max} - a_{\min}} = \frac{43 - 28}{1 - 0.1} = 16.67$$

Calculated the importance coefficients of Influence factor by using the formula

$$a_i = \frac{\Sigma A_i - \Sigma A_{\min}}{d} + 0.1, \text{ then use } a_i \text{ indicated the coefficient, The results are shown in the last row}$$

of Table 5, then get the fuzzy vector $\tilde{A} = (1.000, 0.460, 0.100)$

Normalizing the $\tilde{A}$, obtained $\tilde{A} = (0.151, 0.069, 0.015)$

established the evaluation matrix of the effect of Table tennis for bodily functions through above results, supposed bodily functions is divided into four different levels of A, B, C, D,

Select 30 individuals for each indicator grading, the results are shown in Table 6.

Normalizing each item get a new evaluation matrix shown in Table 7

TABLE VI. THE TABLE OF THE EVALUATION RESULTS

factors	grade			
	A	B	C	D
<i>heart rate</i>	15	10	5	0
<i>lung capacity</i>	17	12	1	0
<i>Physical fitness</i>	12	18	0	0

TABLE VII. THE EVALUATION MATRIX

factors	grade			
	A	B	C	D
<i>heart rate</i>	0.500	0.333	0.167	0.000
<i>lung capacity</i>	0.567	0.400	0.033	0.000
<i>Physical fitness</i>	0.400	0.600	0.000	0.000

Normalizing the Results of Table 7 can be obtained comprehensive evaluation grading weight table, shown as table 8.

TABLE VIII. COMPREHENSIVE EVALUATION GRADING WEIGHT TABLE

A	B	C	D	comprehensive points
0.489	0.444	0.067	0.000	91.33

A, B, C, D four levels were 100 points, 85 points, 70 points and 60 points, we can calculate comprehensive score is 91.33 according to the weights of each levels.

Conclusion

Using the comprehensive evaluation method to evaluate the impact of table tennis for bodily functions can considering various factors, Evaluation results illustrate the impact is larger and suitable as a good fitness method.

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