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# Fuzzy comprehensive evaluation analysis method-based university students' sports lifestyle and physical quality correlation degree exploration

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## ABSTRACT

With improvement of people's living standard, more people start to focus on health problem, such as the old physical quality, children physical health status, adolescent physical health status. Adolescent as backbone of society, their physical status attracts particular attention. The paper utilizes principal component analysis method to extract principal components of factors that affect physical health status, extracted principal components are pull-up, sit and reach as well as lung capacity. In different lifestyles, analyze university students' physical quality. Sports lifestyle includes dimension one group, dimension two groups, dimension three groups and defective group. By fuzzy comprehensive evaluation analysis method, it makes analysis and result is dimension three groups' physical quality is best, secondly is dimension two groups, dimension one group and defective group. The conclusion conforms to practical situation.

## KEYWORDS

Principal component analysis method; Sports lifestyle; Fuzzy comprehensive evaluation; Physical quality.



## INTRODUCTION

At present, adolescent physical quality declination has already become a universal phenomenon in China or even in the world. Adolescent is an important force of national development and national rejuvenation. Their physical ability quality affects social future development. Therefore, adolescent strengthens physical exercises, promotes physical quality have become focus of numerous experts concerns.

In 2011, Zhang Ge in the article " University students physical exercises promotion research", took Beijing University as research object, utilized multiple ways to study university students' physical exercises influence factors, and carried out correlation questionnaire survey on university students, deepen explored some factors that could be used as influence factors causes, unscrambled sports management policies and sports type community and others social environment factors influences on adolescent physical exercises. Investigation result showed that influence factors included reinforcement, promotion and tendency three parts. Sporty type community members obviously had advantages over non-sports type community members' students in physical health and exercises time, but different types communities had no differences in the two aspects. The author pointed out that healthy behaviors ecology model could be applied in researching physical exercises problems. In students sports participation exercises extent, Beijing University was worse. School every relative department should formulate corresponding regulations to propel to students to participate in physical exercises, and meanwhile positive reference success experiences from high physical exercises schools, and then promoted whole school students' physical quality.

In 2011, Wang Kun in the article "University students physical exercise habits concept model, measuring method and education intervention research", explained that most of people lacked of recognition in physical exercises habits aspects. Such as, sports habits concept and feature. The author took university students as research objects, on the basis of utilizing concept theory model, made habits scale. Took self-decision theory as support, used people's ability demands, relations and independent demands as entry points, designed experiments and combined with practical cases to analyze. Research result shows that in specific environment, by multiple times training, it could form into physical exercise habits, it existed repeatability, automaticity, stability and other features. Utilized 26 pieces of clauses composed habits scale that included behaviors, thinking and effect three dimensions, the scale most indicators meet psychometrics demands, which could apply in practical problems research. Combined with physical exercises existing necessity, the author pointed out reasonable suggestions. Such as, school should open more public, massive movements so as to achieve purpose of forming into students physical exercises habits. To different extents sports base students, teachers should carry out different extents tutoring after class. Used independent way as lecturing main way, fully aroused students physical exercises positivity, and let students to initiative participate in physical exercises.

In 2013, Meng Li in the article " University students' sports lifestyle and physique correlation research — take Shenyang Normal University as an example", regarded Shenyang Normal University students as research objects, comprehensive adopted multiple methods, targeted at students with different sports habits to make classification research. Results showed that sports lifestyle was composed of behavior efficiency, behavior subject, and behavior feature three parts. The author started from students' physical function, physical quality and body shape three aspects, schoolboys, schoolgirls in different dimensions, and it respectively made comparative analysis. The analysis result was that schoolboys in dimension one group status were basically the same as defective group, while had differences in other two groups. For schoolgirls, except for endurance, other aspects had no obviously differences.

The paper bases on referencing lots of literatures, takes schoolboys as research objects, comprehensive considers multiple influence factors, establishes evaluation schoolboys physical quality model so as to make further researches on such problem.

## MODEL ESTABLISHMENT

The purpose of the model establishment is establishing students physical quality evaluation relationships, utilizes students' physical quality relations to prove sorts ways rationality. Take Shenyang Normal University schoolboys as examples, targeted at sports way dimension one group, dimension two groups, dimension group three and defective group, it makes research. Firstly, utilize principal component analysis method to extract all influence factors, and then utilize fuzzy comprehensive evaluation method to evaluate the four groups, finally, analyze results.

### Data collection

Dimension refers to sports lifestyle, sports lifestyle totally has three types, own any one kind of them is called dimension one group, own any two groups of them is called dimension two groups, and own all the three kinds is called dimension three groups. TABLE 1-3 data is from the article "University students' sports lifestyle and physique correlation research — take Shenyang Normal University as an example".

**TABLE 1: Schoolboys sports ways dimension one group and defective group relations**

| | Dimension one | Defective group |
|---|---|---|
| Pull-up(beats) | 5.78 | 5.32 |
| Sit and reach(cm) | 7.5 | 6.45 |
| Lung capacity(ml) | 3789.28 | 3756.67 |
| Height (cm) | 172.87 | 174.43 |
| Weight(kg) | 66.38 | 67.23 |
| Lung body index(ml/kg) | 58.48 | 57.64 |
| Grip(kg) | 42.36 | 41.85 |
| Grip index | 64.51 | 63.75 |
| 50m(sec) | 8.03 | 8.01 |
| Standing long jump(cm) | 217.72 | 220.17 |
| 1000m(sec) | 271.27 | 280.09 |

From TABLE 1, we can see dimension one group and defective group have significant differences in lung capacity, while other items differences are insignificant.

**TABLE 2 : Schoolboys sports ways dimension two groups and defective group relations**

| | Dimension two | Defective group |
|---|---|---|
| Pull-up(beats) | 5.74 | 5.32 |
| Sit and reach(cm) | 8.03 | 6.45 |
| Lung capacity(ml) | 3673.32 | 3756.67 |
| Height (cm) | 173.09 | 174.43 |
| Weight(kg) | 67.41 | 67.23 |
| Lung body index(ml/kg) | 55.57 | 57.64 |
| Grip(kg) | 42.39 | 41.85 |
| Grip index | 63.47 | 63.75 |
| 50m(sec) | 7.99 | 8.01 |
| Standing long jump(cm) | 220.21 | 220.17 |
| 1000m(sec) | 269.69 | 280.09 |

From TABLE 2 we can see dimension two groups and defective group except for having significant differences in lung capacity; they also have gaps in sit and reach item.

**TABLE 3 : Schoolboys sports ways dimension three groups and defective group relations**

| | Dimension three | Defective group |
|---|---|---|
| Pull-up(beats) | 6.4 | 5.32 |
| Sit and reach(cm) | 8.42 | 6.45 |
| Lung capacity(ml) | 3639.8 | 3756.67 |
| Height (cm) | 175.02 | 174.43 |
| Weight(kg) | 70.54 | 67.23 |
| Lung body index(ml/kg) | 52.49 | 57.64 |
| Grip(kg) | 44.27 | 41.85 |
| Grip index | 64.24 | 63.75 |
| 50m(sec) | 7.79 | 8.01 |
| Standing long jump(cm) | 227.14 | 220.17 |
| 1000m(sec) | 256.95 | 280.09 |

From TABLE 3 data, we can find that most of items have differences. Due to influence factors are numerous; therefore we adopt principal component analysis method to extract principal components.

**Principal component extraction**

Main way of principal component analysis is reducing dimension of variables, which is recombining original many variables with correlation into a group of uncorrelated variables to replace original variables. Therefore, we can pay attention to every time observation's variables that have maximum variation, to every time observation's small changed variables that can be used as constant to process and get rid of them, so that it reduces variables number in problem that needs to be considered.

**(1)Principal component theory**

Assume that there is $m$ pieces of original indicators to do principal component analysis, which are recorded as $x_1, x_2, \cdots, x_m$, now it has $n$ pieces of samples, corresponding observation value is $x_{ik}(i = 1,2,\cdots,n)$, and $k = 1,2,\cdots,m$ takes standardization transformation, and then transform $x_k$ into $x_k^*$, that:

$$x_k^* = \frac{x_k - \overline{x_k}}{s_k},\ k = 1,2,\cdots,m \quad \textbf{(1)}$$

Among them, $\overline{x_k}$ and $s_k$ are respectively $x_k$ average number and standard deviation, $x_k^*$ average number is $0$, standard deviation is $1$.

According to each sample original indicator observation value $x_{ik}$ or after standardization observation value $x_{ik}^*$, it solves coefficient $b_{kj}$, establish indicator $x_k^*$ that is transformed through standardization to express comprehensive indicator $z_j$ equation $z_j = \sum_k b_{kj} x_k^*$, which can also establish equation that uses original indicator $x_k$ to express comprehensive indicator $z_j$ :

$$z_j = \sum_k \tilde{b}_{kj}\, x_k^* + a_j \quad \textbf{(2)}$$

There are two requirements on defining $b_{kj}$ :

(1) Comprehensive indicators are mutual independent from each other or uncorrelated.

(2) Every comprehensive indicator reflected each sample gross information content is equal to corresponding feature vector (comprehensive indicator coefficient)feature values. In general, it is required that selected comprehensive indicator feature vales contribution ratios sum to be above $80\%$.

**(2) Principal component extraction result**

Combine with above theoretical process, utilize SPSS software, process with dimension one group, dimension two groups, dimension three groups and defective group data, obtained result is as Figure1.

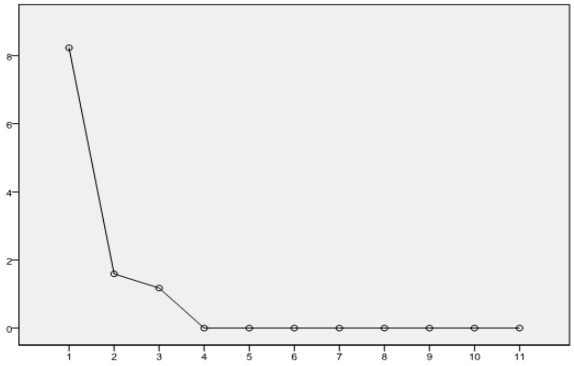


**Figure 1: Scree plot**

From Figure1, we can find component 1, component 2, component 3 are in the relative steeply slope; therefore we take pull-up, sit and reach, and lung capacity as evaluation indicator.

**Fuzzy comprehensive evaluation**

In general, fuzzy comprehensive evaluation involves three quantities. Set that there are $n$ pieces of evaluated objects correlation factors, it records as $U=\{u_1,u_2,\cdots,u_n\}$, and calls it as factor set. And set all possible occurred remarks have $m$ pieces, it records as $V=\{v_1,v_2,\cdots,v_m\}$, and calls it as evaluation set. Because every factor position is different, its function is also different, it appears measurement criterion that is weight, and it records $A=\{a_1,a_2,\cdots,a_n\}$.

**(1) Comprehensive evaluation steps**

Fuzzy comprehensive evaluation steps are proceeding as following methods

(1)Define factor set $U=\{u_1,u_2,\cdots,u_n\}$。

(2)Define evaluation set $V=\{v_1,v_2,\cdots,v_m\}$。

(3)Carry out single factor evaluation and get $r_i=\{v_{i1},v_{i2},\cdots,v_{im}\}$。

(4)Construct comprehensive evaluation matrix:

$$R=\begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \vdots & \vdots & & \vdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix} \quad (3)$$

(5)Comprehensive evaluation:to weight $A=\{a_1,a_2,\cdots,a_n\}$, calculate $B=A\circ R$, and need to make evaluation according to maximum membership principle.

**(2) Operator $\circ$ definition**

When make comprehensive evaluation, according to operator $\circ$ different definitions, it has different models.

(1)Model Ⅰ: $M(\wedge,\vee)$—— Principal divisor decisive type

Computing method is:

$$b_j=\max\{(a_i\wedge r_{ij}),i=1,2,\cdots,n\}(j=1,2,\cdots,m) \quad (4)$$

The model evaluation result is up to factors that play main effects on total evaluation, other factors will not impact on evaluation, relatively, the model is fit for the case that comprehensive evaluation is thought to be optimal when single evaluation is optimal.

(2)Model Ⅱ: $M(\bullet,\vee)$—— Principal divisor prominent type

Computing method is:

$$b_j=\max\{(a_i\bullet r_{ij}),i=1,2,\cdots,n\}(j=1,2,\cdots,m) \quad (5)$$

The model has some similarities with Ⅰ model, but it is more refining than Ⅰ model. It not only highlights main factors, but also gives considerations to other factors. The model is fit for the range that model Ⅰ is inapplicable, which is also in case that each factor cannot be distinguished but needed to be refined.

(3)Model Ⅲ: $M(\bullet,+)$—— Weighted average type

omputing method is:

$$b_j=\sum_{i=1}^{n}a_i\bullet r_{ij}(j=1,2,\cdots,m) \quad (6)$$

The model according to each factor importance, take all influence factors into consideration, relatively it is fit for the case that requires comprehensive optimization.

(4)Model Ⅳ: $M(\wedge,\oplus)$—— Taking sum of small upper bound type

omputing method is:

$$b_j = \min\left\{\left(1, \sum_{i=1}^{n}\left(a_i \wedge r_{ij}\right)\right)\right\}\left(j = 1,2,\cdots,m\right) \quad \textbf{(7)}$$

When use the model, it should pay special attention to : every $a_i$ cannot take excessive big value, otherwise it may appear the case that $b_j$ is $1$ ;every $a_i$ cannot take excessive small value, otherwise it will appear the case that $b_j$ is equal to the sum of each $a_i$, which will lead to single factor evaluation relative information lose.

(5)Model Ⅴ: $M(\wedge,+)$—— Balanced average type

Computing method is:

$$b_j = \sum_{i=1}^{n}\left(a_i \wedge \frac{r_{ij}}{r_0}\right)\left(j = 1,2,\cdots,m\right) \quad \textbf{(8)}$$

Among them, $r_0 = \sum_{k=1}^{n} r_{kj}$ . The model is fit for comprehensive evaluation matrix $R$ element is excessive big or small cases.

The paper established model uses principal divisor decisive type's operator.

**Establish process**

The paper through dimension one, two, three group and defective group evaluation, establish a group of evaluating physical quality reasonable model, so as to later period relative problems research. By principal component analysis, we define three main factors they are respectively pull-up, sit and reach, lung capacity. Therefore, we need to establish the problem factor set $U = \{u_1, u_2, u_3\}$, from which $u_1$ represents pull-up, $u_2$ represents sit and reach, $u_3$ represents lung capacity. Due to it needs to make comparison among four groups, firstly it needs to conclude used data as TABLE 4, and then carry out horizontal normalization on data, as TABLE 5.

**TABLE 4 : Evaluation indicator data status**

| Indicator | Dimension one | Dimension two | Dimension three | Defective group |
|---|---|---|---|---|
| Pull-up(beats) | 5.78 | 5.74 | 6.4 | 5.32 |
| Sit and reach(cm) | 7.5 | 8.03 | 8.42 | 6.45 |
| Lung capacity(ml) | 3789.28 | 3673.32 | 3639.8 | 3756.67 |

**TABLE 5 : Standardized data**

| Indicator | Dimension one | Dimension two | Dimension three | Defective group |
|---|---|---|---|---|
| Pull-up | 0.249 | 0.247 | 0.275 | 0.229 |
| Sit and reach | 0.247 | 0.264 | 0.277 | 0.212 |
| Lung capacity | 0.255 | 0.247 | 0.245 | 0.253 |

In order to make comparison among dimension one group, dimension two groups, dimension three groups and defective group data, we draw broken line graph as Figure 2 shows.

From Figure 2, we can see that differences in pull-up and sit-and-reach two items are larger, while differences in lung capacity are relative small.

According to experience, we set lung capacity weight value as 0.4, both sit and up and pull-up weight values as0.3, as Figure 3 shows.

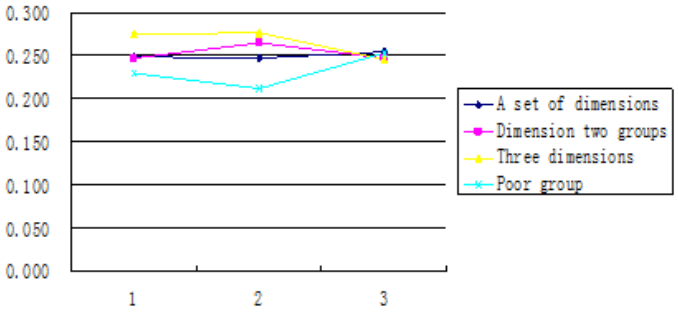


**Figure 2 : Comparison of the four groups**

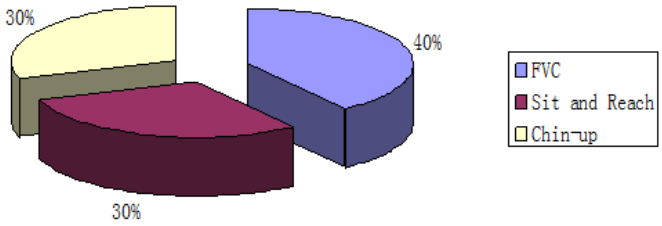


**Figure 3 : Weight chart**

From Figure 3, we can see the evaluation physical quality process used weight is:

$A = (0.3,0.3,0.4)$

According to TABLE 5 data, establish fuzzy comprehensive evaluation matrix:

$$R = \begin{bmatrix} 0.249 & 0.247 & 0.275 & 0.229 \\ 0.247 & 0.264 & 0.277 & 0.212 \\ 0.255 & 0.247 & 0.245 & 0.253 \end{bmatrix}$$

Take model I —— $M(\wedge,\vee)$ as evidence weight, calculate and get:

$$B = A \circ R = (0.255,0.264,0.277,0.253)$$

Therefore, by evaluation, dimension one group evaluation result is 0.255, dimension two groups evaluation result is 0.264, dimension three groups evaluation result is 0.277, defective group evaluation result is 0.253, carry out standardized processing with evaluation result, it gets result graph as Figure 4 shows.

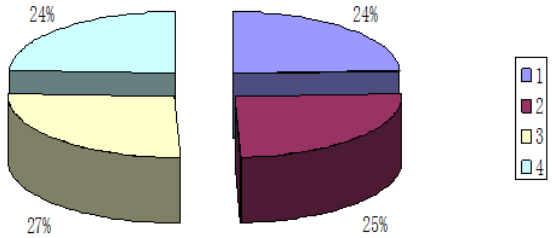


**Figure 4 : The results figure**

In Figure 4, mark number "1"represents dimension one group, mark number "2" represents dimension two groups, mark number "3" represents dimension three groups, mark number "4"represents defective group. From Figure 4, we can see that dimension three groups physical quality is best, defective group physical quality is worst. Dimension one group and dimension two groups physical quality status are basically the same, the conclusion basically conforms to practical life, and therefore, the evaluation model possesses rationality.

## CONCLUSION

The paper used fuzzy comprehensive evaluation method generally will solve a kind of arrangement and selective difficulties. The key to whole process is establishing fuzzy comprehensive evaluation matrix. The method is easier to use, has smaller limitations, therefore, it is widely applied in all kinds of problems. But the method also has its drawbacks, used weights in the process, in general, it needs artificial estimation, once weight is unreasonable, it will lead to result irrationality.

The paper applies fuzzy comprehensive evaluation into researching on university students' sports exercising ways and physical quality problems, obtained result are dimension three groups' physical quality is best, defective group physical quality is worst. The result conforms to practical situation. Established evaluation model conforms to practical life rules. Therefore, the model can popularize in other similar problems. Dimension three groups own sports three kinds of life habits, therefore, relative department should encourage students to form into comprehensive sports life habits.

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