The establishment of Chinese elderly men physique comprehensive evaluation model

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Abstract: The use of Delphi method, AHP, principal component analysis, multiple correlation coefficient method and equally weighted method of weight calculation method and Chinese old people's physical fitness research group database part of elderly male data calculated five kinds of quantitative comprehensive evaluation function. This paper gives the quantitative comprehensive evaluation principle and method， and comparison of five kinds of comprehensive evaluation result. The research shows that equal rights method is the best and it fully embodies the principle of comprehensive and balanced development when make comprehensive evaluation of elderly male physique.

Key words: comprehensive evaluation, weight, indicators consistent method

1. Introduction: With the development of an aging global population, how to evaluate the human physical condition becomes a hot issue of physical research. In recent years, comprehensive evaluation theories and application activities in the sports field has been greatly developed. Although many scholars have done a lot of beneficial research on then weight problem in different studies, but experts still do not agree with each other. Comprehensive evaluation method to determine the weight has become the weak point of the physical research. Comparison of the physical field weighting method and empirical research has theoretical significance and practical value to enhance the national physical fitness.

2. Research Objects and Methods: Comparison of various methods about Chinese elderly men physical condition evaluation. The research methods include expert interviews, questionnaires and empirical methods.

The Research data are obtained from part of the older men data in the aged research group database，with 14 survey cities, ages 60-64, and sample size of 1400.

In order to determine the rationality and feasibility of the index system of the study, we designed questionnaires for the empirical research, and made a survey of 36 experts in the field of physical research in China. The survey was arranged in two passes, first 20 experts, second 16 experts. We conducted interviews with experts in the process of survey to get their opinions and suggestions on the study. The first questionnaire' purpose was to make the index system more reasonable, the second questionnaire's purpose was to calculate the various indicators weights by using the Analytic Hierarchy Process (AHP) and the Delphi method.

After combination of the opinions of experts, we constructed the evaluation index system of 60-64 age group of elderly male physique as follows,

Morphology indicators: Quetelet index x_1, Waist hip ratio x_2, Upper arm skinfold thickness + the subscapular angle skinfold thickness x_3

Functional indicators: Vital capacity x_4 , Sit station index x_5

Physical quality indicators: Grip strength x_6 , Eye-hand coordination x_7 , Reaction time x_8 , Single leg standing with eyes closed x_9 ,Shoulder flexibility (touch back test) x_{10}

Statistical analysis was done using SPSS software for data calculation and empirical analysis

3.Results and Discussion：There are a variety of weights calculated，however, in a practical applications, some are suitable, some are not. In this empirical study, Delphi method, AHP, principal component analysis (PCA), multiple correlation coefficient method(MCCM) and equally weighted method(EW) were used to calculate weights. The calculation results are shown in Table 1:

Table 1 Five weight calculation results table

		Delphi	AHP	PCA		MCCM	EW	
Morphology	x_1	0.044	0.017	0.19		0.041	0.1	
	x_2	0.079	0.048	0.09		0.061	0.1	
	x_3	0.097	0.056	0.08	0.36	0.047	0.1	0.3
		0.22	0.12			0.15		
Functional	x_4	0.155	0.137	0.15		0.06	0.1	
	x_5	0.215	0.25	0.07	0.22	0.137	0.1	0.2
		0.37	0.39			0.20		
Physical quality	x_6	0.094	0.056	0.16		0.058	0.1	
	x_7	0.082	0.102	0.08		0.263	0.1	
	x_8	0.082	0.11	0.09		0.198	0.1	
	x_9	0.086	0.124	0.04		0.057	0.1	
	x_{10}	0.066	0.10	0.05	0.42	0.076	0.1	0.5
		0.41	0.49			0.65		

It can be seen from Table 1 that among the first-level indices, a common feature is that the physical quality indicators have maximum weights, which means that physical quality indicators were the most important in the evaluation of the physical condition of the older men. The calculation results show that the functional index weights are relatively large in the Delphi method, AHP, multiple correlation coefficient method，while the morphological index is more important indicator of the physique condition of the evaluation of older men in the principal component analysis method. In the PCA result, the weights value of the morphological indices exceeds the weights value of functional index, this is hard to explain. One explanation is that poor body shape would produce negative effect on physical function and physical quality. It can be seen from the weights of the second-level indices that the weights of the sit station index x_5 and the eye-hand coordination x_7 have better conformability among the four evaluation methods, their relatively larger weight values show they are important

evaluation indicators of the physical condition of the older men. Besides, the reaction time x_8 is also an important indicator.

The evaluation function using weights from the Delphi method to calculate the is：

$$y = 0.044x_1 + 0.079x_2 + 0.097x_3 + 0.155x_4 + 0.215x_5 + 0.094x_6 + 0.082x_7 + 0.082x_8 + 0.086x_9 + 0.066x_{10}$$

The evaluation function using weights from the AHP method is：

$$y = 0.017x_1 + 0.048x_2 + 0.056x_3 + 0.137x_4 + 0.25x_5 + 0.056x_6 + 0.102x_7 + 0.11x_8 + 0.124x_9 + 0.10x_{10}$$

The evaluation function using weights(after normalization) from the principal component analysis method(PCA) is：

$$y = 0.19x_1 + 0.09.x_2 + 0.08x_3 + 0.15x_4 + 0.07x_5 + 0.16x_6 + 0.08x_7 + 0.09x_8 + 0.04x_9 + 0.05x_{10}$$

The evaluation function using weights from the multiple correlation coefficient method (MCCM) is：

$$y = 0.041x_1 + 0.061.x_2 + 0.047x_3 + 0.06x_4 + 0.137x_5 + 0.058x_6 + 0.263x_7 + 0.198x_8 + 0.057x_9 + 0.076x_{10}$$

The evaluation function using weights from the equally weighted method(EW) is：

$$y = 0.1x_1 + 0.1.x_2 + 0.1x_3 + 0.1x_4 + 0.1x_5 + 0.1x_6 + 0.1x_7 + 0.1x_8 + 0.1x_9 + 0.1x_{10}$$

The uniformization method of evaluation indicators: the Quetelet index x_1 is a centered indicator. Vital capacity x_4 ， Sit station index x_5, Grip strength x_6, Single leg standing with eyes closed x_9 and Shoulder flexibility (touch back test) x_{10} are high-priority indicator. Waist hip ratio x_2, Upper arm skinfold thickness + the subscapular angle skinfold thickness x_3, Eye-hand coordination x_7 and Reaction time x_8 are low-priority indicator.

China Obesity Task Group recommended that the male waist circumference greater than 85 cm as the diagnosis criterion of central obesity. Male waist to hip ratio of less than or equal to 0.90 or female waist to hip ratio less than or equal to 0.80 is considered to be a healthy sign. Waist-hip ratio greater than or equal to 1 means that the increase in the risk of disease. Here we think the waist to hip ratio is a low priority indicator.

For Quetelet index x_1, the formula is : $x_j^{\bullet} = \begin{cases} \dfrac{2(x_j - m)}{M - m}, if \quad m \le x_j \le \dfrac{M+m}{2} \\ \dfrac{2(M - x_j)}{M - m}, if \quad \dfrac{M+m}{2} \le x_j \le M \end{cases}$

Where m is a of lower bound for the Quetelet index, M is an upper bound for the Quetelet index. In the study let m be the possible minimum value of the Quetelet index(The minimum of 1400 people Quetelet index was 443.1), let M be the possible maximum value of the Quetelet index(The maximum of 1400 people Quetelet index was 251.6). Using the above formula, the Quetelet index is transformed into a high-priority indicator.

Using the formula $x_j^{\bullet} = M - x_j$, the Eye-hand coordination x_7, reaction time x_8, upper arm skinfold thickness + the subscapular angle skinfold thickness x_3 and waist hip ratio x_2 are transformed into high-priority indicators, Where M is an upper bound of the Waist hip ratio x_2 （or upper arm skinfold thickness + the subscapular angle skinfold thickness x_3、or eye-hand coordination x_7、or reaction time x_8）. We take M to be $\max(x_3) = 67$， $\max(x_7) = 23.8$ $\max(x_8) = 0.35$ $\max(x_2) = 113.6$.

The standardization method of evaluation indicators: we choose the standard score method, the formula is:

$$x_{ij}^{*} = \frac{x_{ij} - \bar{x}_j}{s_j}$$

Where x_{ij} is the measured value of index x_j, $\bar{x}_j$ is the sample mean of index x_j, s_j is the sample standard deviation of index x_j. $x_{ij}^{*} \sim N(0,1)$.

After uniformization (the indicators are transformed into high-priority indicators)，standardization，analysis are done using SPSS software, results omitted here.

The comparison of the five comprehensive evaluation method:
The uniformization method of evaluation indicators, the standardization method of evaluation indicators, the choice of evaluation model, the choice of weight coefficients, and the choice of the order of uniformization and standardization will affect the results of comprehensive evaluation.

Generally speaking, the objective standard to compare quantitative comprehensive evaluation results must obey the following principles: the lesser calculation workload

the better, better reflect the overall differences between the evaluation objects(the variability of the evaluation results the bigger the better), choose between emphasizing evaluating balanced development of the evaluation objects and emphasizing the partial development of the evaluation objects.

This research is about the comprehensive evaluation of physical fitness of elderly men. We should emphasize the balanced development of the objects being evaluated using the various indicators. For the optimal choice of evaluation methods, we should think of the following four aspects：Firstly，we should consider the calculation workload. Secondly，we should consider the compatibility of the evaluation methods and other evaluation methods. Thirdly we should consider the difference between the evaluation method and other methods. Fourthly, we should consider the variability from the evaluation method. A good evaluation method should meet the following 4 requirements：smaller calculation workload，better compatibility，the smaller differences with other methods, larger variability.

The compatibility of an evaluation method can be measured with the mean of rank correlation coefficients，the larger the better.

The difference of an evaluation method with others can be measured with the average standard deviation of the differences between the evaluation results of the method and the evaluation results of the other evaluation methods, the smaller the better.

The variability of an evaluation method can be measured with the standard deviation of the evaluation result, the larger the better.

Table2 comparison table of the five comprehensive evaluation methods

	the mean of rank correlation coefficients	the standard deviation of the evaluation value	the average standard deviation of the differences
Delphi	0.889	0.425	0.2033
AHP	0.871	0.450	0.2174
PCA	0.786	0.570	0.3454
MCCM	0.802	0.488	0.2957
EW	0.8995	0.588	0.2069

The calculation workload of principal component analysis is slightly higher among five evaluation methods. There are no significant differences among the other four calculation methods. According to the above four criteria, it can be seen from table 2: the standard deviation of the evaluation values of the equal weight method is the largest, which reflects the overall difference of the object being evaluated. The average standard deviation of the differences of it is the smallest and the mean of rank correlation coefficients of it is the largest. It can therefore be considered equal weight method in the comprehensive evaluation of physical fitness in elderly men is better method, followed by the Delphi method.

4.Conclusion: The comprehensive evaluation of physical fitness was carried out using the older men data (aged 60-64 years) in the aged research group database. It obtained five comprehensive evaluation functions and evaluated the physical condition of the 1,400 men and made the comprehensive evaluation criteria of Chinese older men physique. Comprehensive evaluation results of the comparison showed that the weighted method is best for the comprehensive evaluation of Chinese older men physique. It can best show the principle of comprehensive and balanced development，followed by the Delphi method.

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