



Study on the Comprehensive Evaluation System of Public Health in Colleges and Universities Based on AHP-FUZZY

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Abstract Public health in Colleges and universities is an important part of the management of College education, which is directly related to the healthy growth of students, the overall situation of school and social stability. How to construct a scientific comprehensive evaluation system is an urgent need of public health management in Colleges and universities in the new era, and has important practical significance for the construction of healthy colleges and universities. On the basis of the actual investigation, this paper defines five first-level standards of public health management factors, health education factors, personnel quality factors, improvement factors and crisis management factors, as well as 22 second-level standards of public health five-level work network and establishment of perfect accountability mechanism, and calculates each level by using AHP model. Based on the weight of the target, a fuzzy comprehensive evaluation model is established. At the same time, the comprehensive evaluation and calculation of the actual data of public health service in A University verify the feasibility of the index system, thus providing a reference for the scientific management and service of public health work in Colleges and universities.

Keywords Public health; AHP; Index system; Fuzzy Comprehensive; Evaluation Model

1. Introduction

Since the reform and development, China's higher education has achieved leapfrog development. By the end of 2017, the number of college students has reached more than 27 million. As a place for training high-level talents, public health safety cannot be ignored. In recent years, public health incidents in Colleges and universities continue to occur. Strengthening public health service management in Colleges and universities is not only related to the vital health interests of every staff member, but also plays an important role in ensuring the sustainable development of colleges and universities. Through the study of the evaluation system of public health in Colleges and universities, we can deeply understand the laws and methods of public health service and management in Colleges and universities, so as to improve the level of public health service in Colleges and universities. However, so far, the research on the comprehensive evaluation system of public health in Colleges and universities has not been carried out, and needs to be further studied and discussed. Based on this, building a scientific and reasonable comprehensive evaluation index system has become an urgent issue in the research of public health management science in Colleges and universities.

2. Construction of Evaluation Index System of Public Health in Colleges and Universities

Public health is a systematic project of school construction. By analyzing the factors influencing the public health work in Colleges and universities, as well as the laws and characteristics of public health work in Colleges and universities, the relevant literature and information of public health management in Colleges and universities and the opinions of some public health experts are retrieved and analyzed. Based on the actual data of school public health service and the three basic processes of designing the index system proposed by



American scholar L.J. Cronbach: divergence, convergence and the steps of experiment revision, the index system of public health standardization construction in Colleges and universities is preliminarily constructed by Delphi method. As shown in Figure 1.

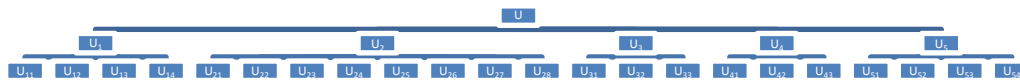


Figure 1: Framework Diagram of Comprehensive Evaluation Index System of Public Health in Colleges and Universities

U—{Comprehensive Evaluation Index System of Public Health in Colleges and Universities}.

U={U₁,U₂,U₃,U₄,U₅}={Management Factor, Health Education Factor, Personnel Quality Factor, Improvement Factor, Crisis Management Factor}.

U₁={U₁₁,U₁₂,U₁₃,U₁₄}={Public health organizations improve the division of responsibilities is clear;five-level public health work network system ; sound system, establish a sound accountability mechanism ; conditions in place to ensure that public health work continues to carry out}.

U₂={U₂₁,U₂₂,U₂₃,U₂₄,U₂₅,U₂₆,U₂₇,U₂₈}={Health education is included in the school teaching plan system ; the popularization of public health cultural knowledge (infectious diseases such as tuberculosis) ; emergency knowledge and skills training for teachers and students ; complete mental health education system ; Campus health and epidemic prevention is carried out in a planned way ; School Health Institutions Provide Professional Health Services; Perfect Health Record System for Teachers and Students; campus food and environmental hygiene in line with relevant standards}.

U₃={U₃₁,U₃₂,U₃₃}={Public health practitioners meet the requirement; psychological quality and emergency ability of teachers and students; the effectiveness of public health education} ;

U₄={U₄₁,U₄₂,U₄₃}={Public health performance appraisal reward and punishment mechanism ; internal inspection; external inspection};

U₅={U₅₁,U₅₂,U₅₃,U₅₄}={Emergency plans and preventive measures for public health emergencies; daily data statistics; crisis forecasting and monitoring; establishment of information reporting and dissemination system}.

3. Evaluation of Public Health Indicator System in Colleges and Universities Based on AHP Model

3.1 Specific steps of chromatography analysis

3.1.1 Constructing the Structure Model of Analytic Hierarchy Process

The comprehensive evaluation project of public health in Colleges and universities is divided into three levels, namely, the highest level, the middle level and the grass-roots level. The structure model of the specific level analysis is shown in Figure 1.

3.1.2 Constructing judgement matrix

Invite public health management experts, starting from the second level of the hierarchical analysis structural model, to construct a comparative judgment matrix by comparing two or two factors subordinate to the previous level, using pairwise comparison method and 1-5 comparison scale.

3.1.3 Data Processing and Weighting of Indicators

The constructed judgment matrix is input into the MATLAB program and the weights of each index are calculated.

3.1.4 Consistency check

The consistency index is calculated by formula $CI = \frac{\lambda - n}{n - 1}$, and then the consistency ratio is calculated by formula

$CR = \frac{CI}{RI}$, and revised.

3.2 Weight calculation of index system

AHP model and Delphi method with reliability are used to determine the weight of comprehensive evaluation index system of public health in Colleges and universities. According to the model and steps of analytic hierarchy process, the judgment matrices of U-(U₁, U₂, U₃, U₄, U₅) and U₁-(U₁₁, U₁₂, U₁₃, U₁₄), U₂-(U₂₁, U₂₂, U₂₃, U₂₄, U₂₅, U₂₆, U₂₇, U₂₈), U₃-(U₃₁, U₃₂, U₃₃), U₄-(U₄₁, U₄₂, U₄₃), U₅-(U₅₁, U₅₂, U₅₃, U₅₄) are constructed as follows:

$$U = \begin{pmatrix} 1 & 1/5 & 3 & 2 & 2 \\ 5 & 1 & 4 & 2 & 3 \\ 1/3 & 1/4 & 1 & 1/2 & 2 \\ 1/2 & 1/2 & 2 & 1 & 2 \\ 1/2 & 1/3 & 1/2 & 1/2 & 1 \end{pmatrix} \quad U_1 = \begin{pmatrix} 1 & 1/2 & 1/4 & 2 \\ 2 & 1 & 1/2 & 3 \\ 4 & 2 & 1 & 2 \\ 1/2 & 1/3 & 1/2 & 1 \end{pmatrix} \quad U_2 = \begin{pmatrix} 1 & 1/3 & 2 & 1/4 & 1/3 & 3 & 4 & 1/2 \\ 3 & 1 & 2 & 1/2 & 3 & 5 & 4 & 2 \\ 1/2 & 1/2 & 1 & 1/2 & 2 & 3 & 2 & 1/3 \\ 4 & 2 & 2 & 1 & 2 & 3 & 3 & 1/2 \\ 3 & 1/3 & 1/2 & 1/2 & 1 & 2 & 2 & 1/3 \\ 1/3 & 1/5 & 1/3 & 1/3 & 1/2 & 1 & 1/3 & 1/2 \\ 1/4 & 1/4 & 1/2 & 1/3 & 1/2 & 3 & 1 & 1/3 \\ 2 & 1/2 & 3 & 2 & 3 & 2 & 3 & 1 \end{pmatrix}$$

$$U_3 = \begin{pmatrix} 1 & 1/3 & 1/4 \\ 3 & 1 & 1/2 \\ 4 & 2 & 1 \end{pmatrix} \quad U_4 = \begin{pmatrix} 1 & 1/2 & 2 \\ 2 & 1 & 2 \\ 1/2 & 1/2 & 1 \end{pmatrix} \quad U_5 = \begin{pmatrix} 1 & 2 & 1/3 & 2 \\ 1/2 & 1 & 1/2 & 2 \\ 3 & 2 & 1 & 3 \\ 1/2 & 2 & 1/3 & 1 \end{pmatrix}$$

The six judgment matrices mentioned above are input into the program of MATLAB, and the weight vector “w”, characteristic values, satisfactory consistency index and random consistency ratio of each judgment matrix are calculated respectively.

$$\omega^{(1)} = (0.20 \quad 0.43 \quad 0.11 \quad 0.17 \quad 0.09) \quad \lambda = 5.376 \quad CI = 0.094 \quad CR = 0.084$$

$$\omega_1^{(2)} = (0.16 \quad 0.29 \quad 0.43 \quad 0.12) \quad \lambda = 4.205 \quad CI = 0.068 \quad CR = 0.076$$

$$\omega_2^{(2)} = (0.10 \quad 0.22 \quad 0.09 \quad 0.20 \quad 0.10 \quad 0.04 \quad 0.06 \quad 0.19) \quad \lambda = 8.932 \quad CI = 0.133 \quad CR = 0.094$$

$$\omega_3^{(2)} = (0.13 \quad 0.32 \quad 0.55) \quad \lambda = 3.018 \quad CI = 0.009 \quad CR = 0.016$$

$$\omega_4^{(2)} = (0.3 \quad 0.5 \quad 0.2) \quad \lambda = 3.054 \quad CI = 0.027 \quad CR = 0.047$$

$$\omega_5^{(2)} = (0.23 \quad 0.19 \quad 0.45 \quad 0.13) \quad \lambda = 4.143 \quad CI = 0.048 \quad CR = 0.053$$

The results show that the CR values of the random consistency ratios of the judgment matrices U, U₁, U₂, U₃, U₄, U₅ are all less than 0.10. All of them pass the consistency test. The weight vectors obtained above can be used as the weights of the comprehensive evaluation index system of public health in Colleges and universities. Details are shown in Table 1.

Table 1: Index System and Weight of Comprehensive Evaluation of Public Health in Colleges and Universities

Index System and Weight of Comprehensive Evaluation of Public Health in Colleges and Universities	First level index	weight	Two level index	weight
	Institutional factors of public health		0.20	Public health organizations improve the division of responsibilities is clear
five-level public health work network system				0.29
sound system, establish a sound accountability mechanism				0.43
conditions in place to ensure that public health work continues to carry out				0.12
Health education factors in public health		0.43	Health education is included in the school teaching plan system	0.10
			the popularization of public health cultural knowledge (infectious diseases such as tuberculosis)	0.22

			emergency knowledge and skills training for teachers and students	0.09
			complete mental health education system	0.20
			Campus health and epidemic prevention is carried out in a planned way	0.10
			School Health Institutions Provide Professional Health Services	0.04
			Perfect Health Record System for Teachers and Students	0.06
			campus food and environmental hygiene in line with relevant standards	0.19
	Quality factors of public health personnel	0.11	public health practitioners meet the requirement	0.13
			psychological quality and emergency ability of teachers and students	0.32
			the effectiveness of public health education	0.55
	Public health improvement factors	0.17	Public health performance appraisal reward and punishment mechanism	0.3
			internal inspection	0.5
			external inspection	0.2
	Public health crisis management factors	0.09	Emergency plans and preventive measures for public health emergencies	0.23
			daily data statistics	0.19
			crisis forecasting and monitoring	0.45
			establishment of information reporting and dissemination system	0.13

4. Case Analysis of Fuzzy Comprehensive Evaluation--- Case Study of A University

Taking A University as an example, based on the above-mentioned comprehensive evaluation index system of public health in Colleges and universities as the evaluation criteria, this paper uses the fuzzy comprehensive evaluation method to evaluate the status quo of public health services in A university. Firstly, three public health experts and two scholars who are engaged in the research of school health work in the Municipal Health Supervision Institute are invited as evaluation groups to evaluate the current situation of A university based on the above evaluation criteria in the form of questionnaires. Through the analysis of data, the implementation effect of public health management and service in A University is evaluated. The detailed calculation process is as follows:

4.1 Determining Fuzzy Comprehensive Evaluation Factor Set

Factor set:

$$U = \{U_1, U_2, U_3, U_4, U_5\}; U_1 = \{U_{11}, U_{12}, U_{13}, U_{14}\}; U_2 = \{U_{21}, U_{22}, U_{23}, U_{24}, U_{25}, U_{26}, U_{27}, U_{28}\}; U_3 = \{U_{31}, U_{32}, U_{33}\}; U_4 = \{U_{41}, U_{42}, U_{43}\}; U_5 = \{U_{51}, U_{52}, U_{53}, U_{54}\}.$$

4.2 Establishment of evaluation set for comprehensive evaluation

The purpose of comprehensive evaluation is to evaluate the effect of public health work in A university. The evaluation set is: $V = \{V_1, V_2, V_3, V_4\} = \{\text{Excellent, Preferably, Commonly, Difference}\}.$

In order to facilitate calculation, each factor in the evaluation set is assigned $C = \{90, 80, 70, 60\}$ respectively. The quantitative grading table of the evaluation grade designed is shown in Detailed Table 2.



Table 2: Quantitative Grading Table for Comprehensive Evaluation of Public Health in Colleges and Universities

Evaluation	Comment
$P \geq 90$	Excellent
$80 \leq P < 90$	preferably
$70 \leq P < 80$	Commonly
$P < 70$	Difference

4.3 Comprehensive evaluation

4.3.1 Stratified comprehensive evaluation

Through the analysis of the data of the evaluation group, it can be concluded that the fuzzy evaluation of U_1, U_2, U_3, U_4, U_5 constitutes a single factor evaluation matrix:

$$R_1 = \begin{pmatrix} 0.1 & 0.4 & 0.4 & 0.1 \\ 0 & 0.3 & 0.4 & 0.3 \\ 0.2 & 0.5 & 0.3 & 0 \\ 0.1 & 0.3 & 0.4 & 0.2 \end{pmatrix} \quad R_2 = \begin{pmatrix} 0 & 0.4 & 0.5 & 0.1 \\ 0.2 & 0.2 & 0.5 & 0.1 \\ 0.1 & 0.4 & 0.5 & 0 \\ 0.3 & 0.5 & 0.2 & 0 \\ 0.2 & 0.4 & 0.1 & 0.3 \\ 0 & 0.2 & 0.6 & 0.2 \\ 0 & 0.3 & 0.4 & 0.3 \\ 0.2 & 0.4 & 0.4 & 0 \end{pmatrix}$$

$$R_3 = \begin{pmatrix} 0.3 & 0.4 & 0.3 & 0 \\ 0.1 & 0.4 & 0.5 & 0 \\ 0.2 & 0.3 & 0.4 & 0.1 \end{pmatrix} \quad R_4 = \begin{pmatrix} 0.1 & 0.3 & 0.4 & 0.2 \\ 0.1 & 0.4 & 0.4 & 0.1 \\ 0.4 & 0.5 & 0.1 & 0 \end{pmatrix} \quad R_5 = \begin{pmatrix} 0.3 & 0.4 & 0.3 & 0 \\ 0.2 & 0.3 & 0.4 & 0.1 \\ 0 & 0.3 & 0.4 & 0.4 \\ 0.1 & 0.3 & 0.5 & 0.1 \end{pmatrix}$$

The weights of U_1, U_2, U_3, U_4, U_5 are respectively :

- A1={0.16,0.29,0.43,0.12} ;
- A2={0.10,0.22,0.09,0.20,0.10,0.04,0.06,0.19} ;
- A3={0.13,0.32,0.55} ;
- A4={0.3,0.5,0.2} ;
- A5={0.23,0.19,0.45,0.13} ;

Calculated by model $M = (\Lambda, \nu)$

- B1= A1·R1=(0.2,0.43,0.3,0.29)
- B2= A2·R2=(0.2,0.2,0.22,0.1)
- B3= A3·R3=(0.2,0.32,0.4,0.1)
- B4= A4·R4=(0.2,0.4,0.4,0.2)
- B5= A5·R5=(0.23,0.3,0.4,0.3)

4.3.2 High-level comprehensive evaluation

$U=\{U_1, U_2, U_3, U_4, U_5\}$, weight $A=\{0.20, 0.43, 0.11, 0.17, 0.09\}$, U-level evaluation matrix:

$$R = (B_1, B_2, B_3, B_4, B_5)^T = \begin{pmatrix} 0.2 & 0.43 & 0.3 & 0.29 \\ 0.2 & 0.2 & 0.22 & 0.1 \\ 0.2 & 0.32 & 0.4 & 0.1 \\ 0.2 & 0.4 & 0.4 & 0.2 \\ 0.23 & 0.3 & 0.4 & 0.3 \end{pmatrix}$$

$$B = A \cdot R = (0.2, 0.2, 0.22, 0.2)$$

According to the principle of maximum membership degree, the evaluation of public health work in A university is "general", which conforms to the actual situation of A university. It can be seen that the evaluation

conclusion of this model is credible and can be used as a quantitative and reliable method for the evaluation of public health management in Colleges and universities.

5. Conclusion

Public health in Colleges and universities is a continuous and systematic project. On the basis of qualitative analysis, this paper makes a quantitative and modeled comprehensive evaluation of public health work in Colleges and universities. Through empirical analysis, the system has practicability and operability, can reflect the basic attributes of scientific management of public health in Colleges and universities, and provide constructive guidance for public health work in Colleges and universities, so it has certain popularization value in practice.

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