ISSN : 0974 - 7435 Volume 10 Issue 18

2014

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(18), 2014 [09974-09982]

Analytic hierarchy process-based civil servant physical health status research

Linlin Wang
Institute of Physical Education, *Zhoukou* Normal University, *Zhoukou* 466001, *Henan*, (CHINA)

ABSTRACT

With the development of society, people's living standards have been greatly improved, physical quality improves markedly, but civil servant physical conditions turn an opposite trend, civil servant is related to prolonged stability of future of nation, therefore study civil servant, no matter from the perspective of individuals or nation, all have important significances. Based on the thought, the paper researches on civil servant physical health status, by applying experts interviewing method, market survey method, analytic hierarchy process and else, it defines guidelines layer four indicators that are respectively body function, quality, metabolism and form, and carries out systematic analysis of the factors, establishes civil servant physical health comprehensive evaluation model, defines weight thought analytic hierarchy process, and uses deviation algorithm to hierarchize each factor. Finally obtained positive deviation factors as their evaluation criterion, the model combines with practice; it proves the model's rationality and effectiveness.

KEYWORDS

Civil servant; Physical health; Analytic hierarchy process; Deviation.

INTRODUCTION

With the progress of society and rapidly development of medical science, people's demand on health is also constantly increasing, but in present society, a large proportion of people are in the sub-health status, as far as Chinese civil servant is concerned, sub-health status has become ubiquitous, so research on physical health status has great effects on disease prevention.

Regarding health aspects research, formers have made many efforts, and obtained abundant achievements, such as :Wang Guo-Jun applied analytic hierarchy process method in civil servant physical health conditions to define weights, after that combined fuzzy mathematical method to made comprehensive evaluation on it, and predicted its trend; Li Ting evaluated on students' physical health, established its evaluation system that included organizational benefits layer, behavior layer, learning layer, reaction layer and result layer these five layers, and combined with Shanghai city one school's practical situation to make quantization and verification, finally obtained result reflected evaluation grade and evaluation scores two methods.

The paper just bases on above previous researches, it evaluates on Beijing civil servant physical health, applies experts interviewing method, market survey method, analytic hierarchy process and else to define guidelines layer four indicators, defines weights by analytic hierarchy process, and uses deviation algorithm, hierarchizes each factor, and finally gets its reasonable evaluation results, which let the model to obtain extensive testing and improving in the field.

APPLY ANALYTIC HIERARCHY PROCESS INTO EVALUATING CIVIL SERVANT PHYSICAL HEALTH CONDITIONS

Analytic hierarchy process was earliest proposed by American operational research experts, the method can simplify complicated problems, AHP features are hierarchizing complicated problems, making clear about primary and secondary, possessing stronger logicality and hierarchical structure, the algorithm mainly is calculating indicators weights. It is applicable to comprehensive assessment system, is a powerful mathematical method that converts problems into quantitative research. Nowadays analytic hierarchy process has already widely used in each field to solve practical problems.

Analytic hierarchy process calculates indicators weights

Analytic hierarchy process is the key to solve physical health indicator system aspect weight issue, and selection of weights are mainly experts selection, due to every selected expert has profound researches on his field, emphasis and familiar degree on his field are deeper, so it will be inclined to higher weights, therefore it is inappropriate to select more experts, the paper selects ten experts to evaluate on the weights. During selection process, experts should follow with necessary and reasonable education background; they are of all ages as young and middle-aged as well as old; their affiliated job titles should be in senior title and above; they possess higher prestige in their fields.

According to above principles, the paper selected experts are as following TABLE 1 shows:

TABLE 1 : Experts status table

Expert No.	Name	Age	Gender	Job title	Education background	Unit
1	WWB	41	Female	Sub-senior	Doctor	Nanjing Sport Institute
2	WM	45	Female	Senior	Doctor	Shanghai Sport Institute
3	LHJ	51	Male	Senior	Master	National sports science institute
4	LDJ	52	Female	Sub-senior	Master	Shanghai Sport Institute
5	XWH	51	Female	Sub-senior	Master	Beijing Sport University
6	WRH	42	Male	Senior	Doctor	Beijing Sport University
7	ZJ	34	Male	Sub-senior	Doctor	Shenzhen University
8	XY	54	Male	Senior	Doctor	Shanghai Sport Institute
9	RH	70	Male	Sub-senior	Master	Beijing Sport University
10	SB	42	Male	Senior	Doctor	Beijing Sport University

Expert defined weight proper evaluation methods selection

After certain processing with multiple factors, it can get their individual indicator total evaluation system; the method is called comprehensive evaluation method. For the method, formers have put forward many ways, combines with the paper researched contents, it selects massive scholars common used one type ——weighted geometric mean method、arithmetic mean method.

Regarding weighted geometric mean method, from which let number of evaluation indicators to be n ; let individual indicator evaluation value to be y_i ;let evaluation indicator weight to be w_i ; evaluated object comprehensive evaluation value to be y , so corresponding equation is:

$$y = \prod_{i=1}^{n} y_i^{w_i} \qquad (i = 1, 2, \cdots, n) \tag{1}$$

And corresponding weighted arithmetic mean method equation is:

$$y = \sum_{i=1}^{n} w_i y_i \qquad (i = 1, 2, \cdots, n) \tag{2}$$

Due to the method is relative simple, and it conforms to the paper.

ANALYTIC HIERARCHY PROCESS THEORETICAL MODELS

Civil servant physical health conditions evaluation involves multiple reference indicators, the decision problems is just suitable to analytic hierarchy process. Corresponding flow chart is as following Figure 1 shows:

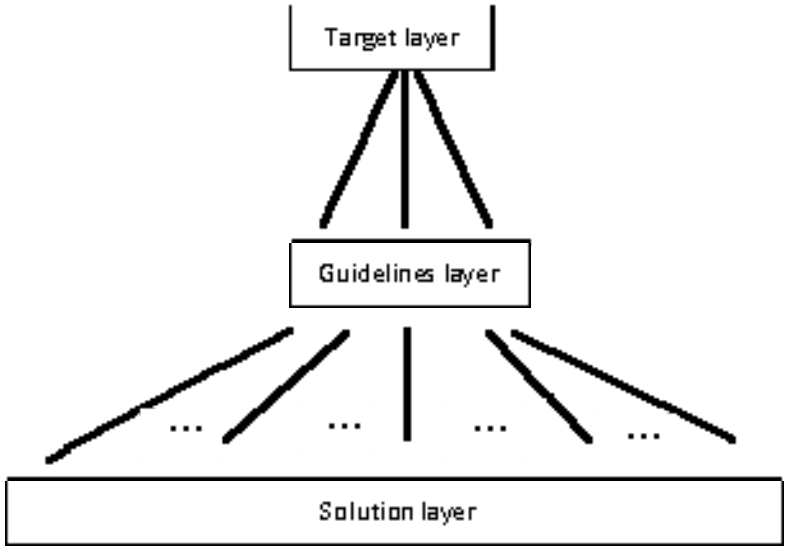

Figure 1: hierarchical model

Construct judgment matrix

For above guidelines layer's three kinds of indicators, it makes meticulous comparison of the two relative importances to construct judgment matrix. Such as :Take T_i, T_j to make importance comparison, the structure is using b_{ij} to express, and then all factors after comparing can get judgment matrix U . Its expression is as following.

$$U = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1j} \\ b_{21} & b_{22} & \cdots & b_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ b_{i1} & b_{i2} & \cdots & b_{ij} \end{pmatrix} \tag{3}$$

In formula, b_{ij} the two compared importance uses quantized value to express,uses 1—9 number to describe, number representative meaning is as following TABLE 2 show:

TABLE 2 : 1—9 scale meaning

Scale	Meaning
1	Indicates two factors have equal importance by comparing
3	Indicates the former is slightly more important than the later by comparing two factors
5	Indicates the former is more important than the later by comparing two factors
7	Indicates the former is relatively more important than the later by comparing two factors
9	Indicates the former is extremely more important than the later by comparing two factors
Even number	Represents importance is between two odd numbers
Reciprocal	Represents factors positive and negative comparison order

Weight vector and maximum feature calculation

According to first grade indicator's judgment matrix vector, carry out normalization with it; solve the sum and then make normalization, then it can get weight vector. According to feature value and feature vector relations, it can solve feature value; its implementation method is as following:

Firstly, normalize judgment matrix every column, its result is:

$$b_{ij} = b_{ij} / \sum_{k=1}^{n} b_{kj} (i, j = 1, 2, \cdots, n) \quad \textbf{(4)}$$

Then solve the sum by lines on judgment matrix that makes normalization by column, it can get:

$$\overline{W_i} = \sum_{j=1}^{n} b_{ij} (i = 1, 2, \cdots, n) \quad \textbf{(5)}$$

Above vector $\overline{W} = \left[\overline{W_1}, \overline{W_2}, \cdots, \overline{W_n}\right]^T$ proceeds with normalization processing:

$$\overline{W_i} = \frac{\overline{W_i}}{\sum_{j=1}^{n} \overline{W_j}} (i = 1, 2, \cdots, n) \quad \textbf{(6)}$$

Then:$W=[W_1,W_2,\ldots,W_n]^T$ is solved feature vector.

In addition, calculate maximum feature root,the process is:

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} \quad \textbf{(7)}$$

In above formula $(AW)_i$ represents vector AW the i component.

According to above formula, we can respectively solve civil servant physical health status comprehensive assessment analysis first grade indicator, second grade indicator to first grade indicator weight and maximum feature value.

Consistency test

To matrix $U = \left(b_{ij}\right)_{n*n}$, if matrix element meets $b_{ij} b_{jk} = b_{ik}$,then matrix is consistent matrix. Among them, $b_{ij} > 0$, $b_{ij} = 1 / b_{ji}$. In order to use it to calculate factor weight, it requires that matrix inconsistency only under acceptable conditions. When problems are relative complicated, we cannot take all factors into account, which causes paired comparison construct judgment matrix instant, judgment matrix cannot arrive at ideal state consistency.

Judgment matrix consistency indicator CI , and judgment matrix consistency ratio CR , its computational method is as following formula

$$CI = \frac{\lambda_{\max} - n}{n - 1} \quad \textbf{(8)}$$

Among them, n represent order number of judgment matrix that is also the number of compared factors.

$$CR = \frac{CI}{RI} \tag{9}$$

Among them, RI represents Random Consistency Index value,as following TABLE 3 shows.

TABLE 3 : RI value table

n	1	2	3	4	5	6	7	8	9	10	11
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

When $CR \geq 0.1$,it is thought that judgment matrix occurs inconsistency that needs to make adjustment on judgment matrix again. When $CR < 0.1$, judgment matrix inconsistency is within acceptable range.

By calculating, it gets four judgment matrixes' consistency indicator CI,and consistency ratio CR,single hierarchy judgment matrix conforms to consistency requirements by consistency testing; it can be thought that calculated weight is reasonable. Next step is doing combination consistency testing. Assume that in one layer, m pieces of factors weight calculation result is α_m , corresponding consistency indicator value respectively is CI_m , combination consistency test consistency ratio is:

$$CR = \frac{\sum_{j=1}^{m} \alpha_j CI_j}{\sum_{j=1}^{m} \alpha_j RI_j} \tag{10}$$

By calculating, combination consistency ratio calculated value is:

$$CR < 0.1$$

So hierarchical total arrangement's consistency testing meets consistency requirement. It can be thought that civil servant physical health conditions' each indicator weight calculation result is reasonable that can be applied into instructional evaluation.

Weight calculation arrangement

If in one layer, m pieces of factors weight calculation result is α_m , corresponding consistency indicator value respectively is CI_m , in next layer n pieces of factors to A layer calculation weight is β_{nm} ,then in T layer factors total arrangement weight is

$$w_i = \sum_{j=1}^{m} \alpha_i \beta_{ij}$$

APPLY ANALYTIC HIERARCHY PROCESS INTO CIVIL SERVANT EVALUATION

According to experts opinions and consult previous documents, the paper defines civil servant physical health hierarchical system table, from which it including body shape, function, metabolism and quality as well as other elements, specific status is as following TABLE 4 shows:

TABLE 4 : Civil servant health evaluation system

Target layer	Guidelines layer	Solution layer
Physical health (A)	Metabolism (B_1)	Bone metabolism C_{11}
		Blood sugar C_{12}
		Blood fat C_{13}
	Body function (B_2)	Blood pressure C_{21}
		Pulse C_{22}
		Lung capacity C_{23}
		Maximum oxygen uptake C_{24}
	Physical quality (B_3)	One foot standing with eyes closed C_{31}
		Reaction time C_{32}
		Sit-up C_{33}
		Lower limbs explosive power C_{34}
		Grip C_{35}
		Sit and reach C_{36}
	Body shape (B_4)	Waist circumference C_{41}
		Body fat rate C_{42}
		RMI C_{43}

According to above process, combining with analytic hierarchy process theoretical model, we get guidelines layer reflected target layer's judgment matrix, as following Figure 2 shows:

专家序号	B_1/B_2	B_1/B_3	B_1/B_4	B_2/B_3	B_2/B_4	B_3/B_4
1	1/3	3	1/3	5	1	1/5
2	1/3	1/3	3	3	5	5
3	1/5	1/3	1/5	3	1	1/3
4	1/3	1	1/5	3	1	1/3
5	1/3	1/5	1	1/3	5	3
6	1/5	1/3	1/5	3	1	1/3
7	1/3	1	1/5	3	1	1/3
8	5	5	1	3	1/3	1/5
9	1/3	1/3	1/5	1	1/5	1/5
10	1	1	1	1	1	1

Figure 2 : Judgment matrix

By above Figure 2, we can respectively solve each expert matrix weight vector, their weights results are as following:

$$W_1 = \begin{matrix} 0.150894 \\ 0.390813 \\ 0.067481 \\ 0.390814 \end{matrix} \quad W_2 = \begin{matrix} 0.146545 \\ 0.49951 \\ 0.288398 \\ 0.065536 \end{matrix}$$

$$W_3 = \begin{matrix} 0.067481 \\ 0.390814 \\ 0.150892 \\ 0.390814 \end{matrix} \quad W_4 = \begin{matrix} 0.125 \\ 0.375 \\ 0.125 \\ 0.375 \end{matrix}$$

$$W_5 = \begin{matrix} 0.099602 \\ 0.293113 \\ 0.507684 \\ 0.099603 \end{matrix} \quad W_6 = \begin{matrix} 0.067481 \\ 0.390813 \\ 0.150892 \\ 0.390813 \end{matrix}$$

$$W_7 = \begin{matrix} 0.096325 \\ 0.249485 \\ 0.096325 \\ 0.557865 \end{matrix} \quad W_8 = \begin{matrix} 0.428973 \\ 0.128294 \\ 0.065194 \\ 0.377544 \end{matrix}$$

$$W_9 = \begin{matrix} 0.070327 \\ 0.160312 \\ 0.160311 \\ 0.609052 \end{matrix} \quad W_{10} = \begin{matrix} 0.25 \\ 0.25 \\ 0.25 \\ 0.25 \end{matrix}$$

By above result and combining with previous theory, we can solve corresponding maximum features roots that are respectively:

$$\lambda_{\max}1 = 4.04338;\ \lambda_{\max}2 = 4.19747;\ \lambda_{\max}3 = 4.043381;\ \lambda_{\max}4 = 4;\ \lambda_{\max}5 = 4.22134;\ \lambda_{\max}6 = 4.04338;$$
$$\lambda_{\max}7 = 4.04338;\ \lambda_{\max}8 = 4.11468;\ \lambda_{\max}9 = 4.1532;\ \lambda_{\max}10 = 4;$$

Proceed with consistency test with maximum features roots, we can get consistency test result as:

$$CI_1 = 0.0144; CI_2 = 0.06582; CI_3 = 0.0144; CI_4 = 0; CI_5 = 0.0737; CI_6 = 0.0144\ CI_7 = 0.0144;$$
$$CI_8 = 0.03822; CI_9 = 0.05108; CI_{10} = 0$$

For the ten experts, $RI = 0.90$, and then according to above theory,we can calculate and get:

$$CR_1 = 0.01606;\ CR_2 = 0.07313;\ CR_3 = 0.01606;\ CR_4 = 0;\ CR_5 = 0.08197;\ CR_6 = 0.01606;$$
$$CR_7 = 0.01606;\ CR_8 = 0.04247;\ CR_9 = 0.05676;\ CR_{10} = 0;$$

In above result, the ten experts' CR always is far smaller than 0.1,so every expert pass consistency test.

Assume that every expert mastered knowledge and experiences are the same, and then it is available that:

$$\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = \lambda_7 = \lambda_8 = \lambda_9 = \lambda_{10} = 1/10$$

By above weight comprehensive weight method that:

$$WI = \frac{\bar{W}_i}{\sum_{j=1}^{n} \bar{W}_j},\ \bar{W}_i = \prod_{i=1}^{m} W_{li}^{\lambda l},\ i = 1,2,\Lambda,n,m = 10$$

And combine with above values, we can get corresponding comprehensive weights that:

$$\bar{W}_1 = 0.124721;\ \bar{W}_2 = 0.289979;\ \bar{W}_3 = 0.153102;\ \bar{W}_3 = 0.293142$$

$$\sum_{j=1}^{n} \bar{W}_j = 0.124721 + 0.289979 + 0.153102 + 0.293142 = 0.86094$$

Carry out normalization process with the weight, we can get civil servant body metabolism, function, quality and form the four weights are:

$$\overline{W_1'} = \bar{W}_1 / \sum_{j=1}^{n} \bar{W}_j = 0.14486$$

By above process we can get corresponding other three types that :

$$\bar{W}_2' = 0.33681 \ \bar{W}_3' = 0.17783 \ \bar{W}_4' = 0.34048$$

According to above process,we can similarly solve solution layer every indicator weights, as following TABLE 5 shows:

TABLE 5 : Civil servant physical health indicator weight table

Target layer	Guidelines layer	Solution layer	Comprehensive weight total arrangement	Deviation coefficient
$(A)(1)$	$(B_1)(0.34048)$	$C_{11}(0.453807)$	0.058	258.0%
		$C_{12}(0.425)$	0.035	23.5%
		$C_{13}(0.227)$	0.052	-63.0%
	$(B_2)(0.33681)$	$C_{21}(0.110)$	0.034	-24.0%
		$C_{22}(0.5)$	0.188	-70.0%
		$C_{23}(0.101)$	0.039	-45.0%
		$C_{24}(0.559)$	0.039	-64.0%
	$(B_3)(0.17783)$	C_{31}	0.029	4.0%
		C_{32}	0.040	-33.0%
		C_{33}	0.016	-59.0%
		C_{34}	0.055	25.0%
		C_{35}	0.019	5.0%
		C_{36}	0.019	149.0%
	$(B_4)(0.14486)$	$C_{41}(0.399)$	0.067	10.0%
		$C_{42}(0.357)$	0.131	-33.0%
		$C_{43}(0.244)$	0.055	-2.0%

By above deviation, we can get the relationships among guidelines layer's body shape, metabolism, function and quality, that is body metabolism and function present positive deviation status, and for solution layer, it presents more positive deviation, so it can regard them as a unified entirety to calculate its deviation again, finally it gets blood sugar and maximum oxygen uptake is the first layer, but in solution layer, community of positive deviation is smaller than indicator layer of negative deviation.

CONCLUSION

Due to Chinese civil servant present physique is in the state of poor efficiency, so the paper analyzes the condition, it applies analytic hierarchy process method, and invites experts to define relative fields' each indicator weight to make preparation for correctly evaluating civil servant physical health conditions, finally it gets that body metabolism, function, quality and form are in the order from heavy to light, secondly is that the paper introduces deviation, it provides theoretical basis for civil servant body shape changes according to the method.

REFERENCES

[1] Liu Bao, Hu Shan-Lian, Xu Hai-Xia, Gao Jian-Hui; Indices of the equality of essential public health services in China. Chinese Journal of Health Policy, **2(6)**, 13-17 **(2009)**.

[2] Zhang Da-Chao, Li Min; Studies on Evaluation Index System of Public Sports Facilities Development Level in China. China Sport Science, **33(4)**, 3-23 **(2013)**.

[3] Cai Jing-Tai, Fan Bing-You, Wang Ji-Shuai; A Survey of Residents' Satisfaction Degree for Urban Public Sport Services. Journal of Beijing Sport University, **6**, **(2009)**.

[4] Wang Guo-Hong, Zhang Wen-Hui; Construction of the Evaluation Index System of City Community Sports-Taking Shanghai as an Example. Journal of Chengdu Physical Education Institute, **36(2)**, **(2010)**.

[5] Zhang Jie, Wu Ying; The Evaluation Index System of Extracurricular Sports Activities in Secondary Schools in Shanghai under the Background of "Sunshine Sports". Journal of Shanghai Physical Education Institute, **6**, 80-82 **(2012)**.

[6] He Ying, Xu Ming; Study on Evaluating System of Sports Consciousness of Community Residents in Southwest Cities. Journal of Chengdu Physical Education Institute, **33(2)**, 43-45 **(2007)**.

[7] He Ying, Xu Ming; Theoretical and empirical study on evaluation mode of sports service satisfaction degree in city community. Journal of Wuhan Institute of Physical Education, **41(11)**, 40-42 **(2007)**.

[8] Chen Yang, Ma Ge-Sheng; An Empirical Study on Community Sports Service Residents' Satisfaction Index Model. China Sport Science and Technology, **45(4)**, **(2009)**.

[9] He Ying, Xu Ming; Theoretical and empirical study on evaluation mode of sports service satisfaction degree in city community. Journal of Wuhan Institute of Physical Education, **41(11)**, 40-42 **(2007)**.