

AHP AUXILLARY STUDIES ON THE COMPREHENSIVE EVALUATION OF THE EPIDEMIC FACTORS OF KASHIN—BECK DISEASE IN JILIN PROVINCE

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ABSTRACT

The probability accumulation test used for the comprehensive evaluation of the epidemic factors in Kashin—Beck disease involves three independent index: the affected degree, the possibility and the weight. In this paper we used AHP to define the relative index—the weight, thus to quantify the cross affect of the epidemic factors in the epidemic process as well as in the epidemic degree. We proved that AHP has very important significance in the auxiliary studies of the complicated environmental systems.

Key Words Kashin—Beck disease, AHP, Probability Accumulation Test . Analysis on the complicated environmental systems.

INTRODUCTION

The Changbai Mountain of Jilin Province is situated in the Kashin—Beck disease epidemic region in the continent of China, where the occurrence of the disease is very high. The history of Kashin—Beck disease is now 140 Years since it's first discovered in last century in the far—east of Russia, but until recently the etiology of the disease remains obscure. However, the disease is generally regarded as caused by the environment, the pathogenesis is very complicated, but it has been investigated in the following three aspects: the natural environment of the investigated region ; the ecologic chemical environment; the human environment. To make a comprehensive evaluation on such a large system, we used Probability Accumulation test to reflect the overall effect of the affect of the epidemic factors in Kashin—Beck disease, we also used AHP to make the cross—

linked and the mutual—inhibited relationship of the epidemic factors in an orderly and proper order, finally to define the sequence of the importance of each factor.

THE PROBABILITY ACCUMULATION TEST

In this paper, Probability Accumulation Test is used for the comprehensive evaluation. It's basic principle is : three independent index are used to define the affect of each environmental factor in the epidemiology of Kashin—Beck disease. These Three index are: the affected degree, the possibility and the weight. The product of the three index reflected the affecting effect on the epidemiology of the disease caused by the environmental factors; the sum of the successive multiplying product of the three index of all the environmental factors reflected the affecting effect of the epidemiology of kashin—Beck disease; the sum of the successive multiplication of the three index of the environmental factors reflected the overall effect of the epidemic affect of kashin—Beck disease.

If E stands for the affected degree, G for the possibility, W for the weight, then we

have: $Y = \sum_{i=1}^n E_i G_i W_i$ of which, Y stands for the affected degree of the probability.

the affected degree is defined as that affected by the environmental factors of Kashin—Beck disease. The affected degree is divided into five degrees: Zero for no affecting. the affecting (nature) can be negative or positive, and altogether can be divided into 11 degrees. each corresponding degree can be endowed with values.

The possibility is defined as the possible probability affected by the environmental factors: for the affirmative, $P_n = 100\%$; for the very possible; $P_b = 80\%$, the possible: $P_c = 60\%$, the relatively less possible: $P_d = 40\%$; the least possible, $P_e = 20\%$, the impossible, $P_f = 0$

Of the environmental factors of Kashin-Beck disease in Changbai mountain, we have selected 16 to reflect the overall condition of the epidemic factors. According to the relatively substantial research materials on the epidemic factors, we at first defined the definition and the standard of each factor. The affected degree and the possibility of each environmental factor is Omitted here as having limited space.

THE DEFINITION OF THE WEIGHT

The weight is a relative index, indicating the position and the importance of the environmental factor in the overall environment. The definition of the weight is one of the Kernel questions in the comprehensive evaluation by subjective probability accumulation test. The result of the comprehensive evaluation evidently differs with different weight. the intension (connotation) of the weight is different when the evaluating method differs. we divided weight into the value weight and The affecting weight to improve the objectiveness and the preciseness in people's judgement the affecting weight reflects one aspect of the mutual affect between environmental factors, while the value weight deals with other aspects of the weight intension. concerning the present research advance of

the environmental factors in Kashin-Beck disease, the affecting weight is generally quantitatively or qualitatively defined by the above objectiveness ; the value weight is generally defined by subjective judgement , this can not only improve the objectiveness and the accuracy of the weight definition , besides, when the affecting weight is proposed by the objective index , the definition of the value . weight becomes simplified, then the cross-affect between factors in the environmental evaluative system can be neglected.

A The definition of the value weight.

We used AHP to define the value weight, when Kashin-Beck disease is taken as a huge environmental system, the epidemic factors of the system cross-linked and also mutually inhibited, the position or the importance of each factor is different, It's necessary and also possible to arrange these factors in an proper order, AHP is to construct the judged matrix , and further define the importance of the weight sequence of each factors or elements through the established orderly structural model.

Based on the environmental factors of Kashin-Beck disease in the volcanic areas. We established a comprehensive evaluating system of altogether four levels with one object, three subsystems , 8 affecting elements and 20 affecting factors. (see Fig. 1)

Level 1— the total factors affecting the epidemiology of Kashin—Beck disease, ie . the object level :

Level 2— systematic category level, ie . the natural environment, the ecologic environment and the chemical environment;

level 3— the element level , the natural environmental elements , including kinds of geography and water resources and soil ; the ecologic chemical environmental elements includes 4 elements, ie . the chemistry of the drinking water, the soil, grains and human hair ; the human environment includes the food structure and contamination of the water.

Level 4— the affecting factor level . There are altogether 20 basic affecting factors , of these, 7 are natural environmental factors, 10 are ecologic chemical factors and 3 are humane environmental factors.

The only source of AHP information is from the judgement of the relative importance of each elementor factor at each level . The judgement can be indicated by arithmetic values , and then write in the form of matrix, ie. the so-called the judged matrix , the five level quantitating method is used in the judgement in this paper. Now we give examples as follows.

The judged matrix of the ecologic chemical environmental elements:

In this group of element, the main factors affecting the epidemiology of Kashin—Beck disease are : factors of drinking water and soil chemistry, grain chemistry and the content of the chemical elements in the human hair ; of these factors, it's apparent that in Changbai mountain , the epidemiology of Kashin-Beck disease is very sensitive , and is also very closely related to the drinking water, so that comparing with soil chemical factors and grain chemical factors, the endowed values are 3 and 5; since the chemical element content in human hair reflects the affect of other factors, the endowed value is 1. in this way, we can construct the judged matrix of each elementor or factor in different

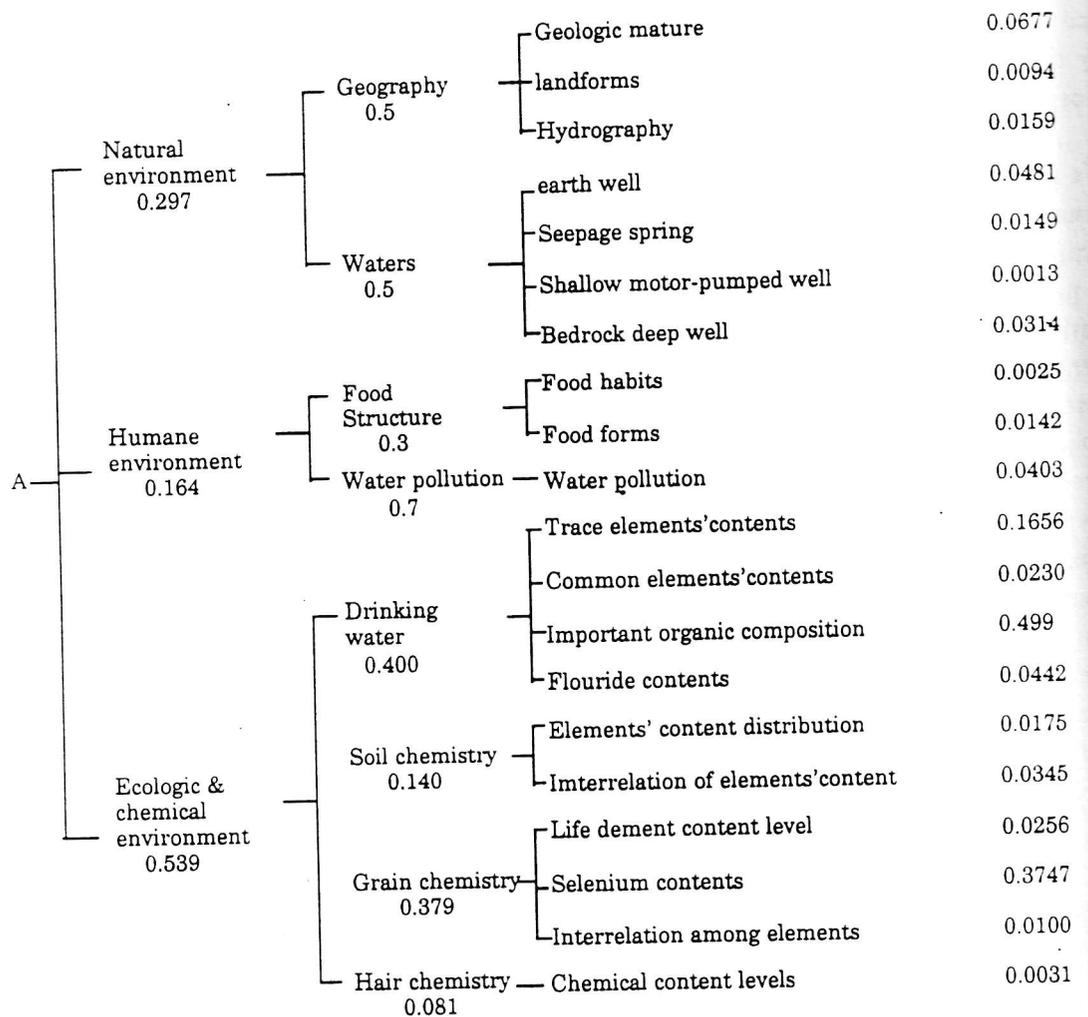


Fig. The graded hierarchy structure of the evaluated total of the epidemic factors of Kasnin-beck disease.

level. the detail is listed in table 1.

The calculated result of the value weight of each element and factor is in table 2

Table 1 The judged matrix of the ecologic chemical environmental factors.

B	C ₁	C ₂	C ₃	C ₄	W _i
C ₁	1	3	5	1	0.400
C ₂	1/3	1	2	1/3	0.140
C ₃	1/5	1/2	1	1/4	0.081
C ₄	1	3	4	1	0.379
λ=0.016 C.L=0.005 R.I.=0.90 C.R.=0.006					

B . The affecting weight:

Suppose there are n factors : B₁ B₂.... B_n, a_{ij} stands for the direct affecting degree of B_i on B_j

then We have the affecting matrix:

$$A = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix}$$

$$a_{i1} = \sum_{j=1}^n a_{ij}, \text{ indicating the first factor affecting the other factors.}$$

$$a_{j1} = \sum_{i=1}^n a_{ij}, \text{ indicating the factor affected by all of the other factors.}$$

multiply the matrix A with a fractionating factor S. We have matrix D . It's obvious that $d_{ij}^{(2)} = \sum_{k=1}^n d_{ik} d_{kj}$ reflected the secondary affect on B_i by B_j through other factors, while $d_{ij}^{(3)} = \sum_{k=1}^n d_{ik}^{(2)} d_{kj}^{(2)}$ reflected the third-step affect on B_i by B_j through other factors

and so on. then we have a matrix sequence :

$$D_1^1 D_2^2 D_3^3 \dots D^m$$

the sum of the 1 to m is:

$$\sum_{i=1}^m D^i = D^1 + D^2 + \dots + D^m$$

if $m \rightarrow \infty, D^m \rightarrow 0$, we have:

$$F = \sum_{i=1}^m D^i = D (I - D)^{-1}$$

of there, I is the unit matrix, F is the direct affecting and indirect affecting matrix if $H = F - D = D^2 (I - D)^{-1}$, then it's the indirect affecting matrix. The sum of the elements in the first line of matrix F reflected all the direct and indirect affect . of factor B_i on all of the other factors, while the sum of the elements in the J line reflected all the direct and the indirect affect on B_j The affecting weight is:

$$W_i = \frac{f_{i1}}{\sum_{i=1}^n f_{i1}} \quad i = 1, 2, \dots, n.$$

The calculated result showed that, the first 6 digits of the affecting weight are: the content of the trace element in the drinking water, the content of flouride, the geologic nature, the selenium content of the grain, the water of the well, the distribution of the amount of each element in the soil, the detail is listed in Table 2.

Table 2

Factors	Value Weights (%)	Affecting Weights (%)	Synthetical Weights (%)
Geologic nature	6.77	13.44	10.11
land forms	0.94	10.81	5.875
Hydrography	1.59	6.89	4.24
Soepage well	1.49	8.13	4.81
Earth well	4.81	11.90	8.36
Shallow motorPumped well	0.73	4.88	2.81
Bedrock deep well	3.14	7.51	5.33
food habits	0.25	4.33	2.29
food Forms	1.42	8.85	5.14
Water pollution	4.03	7.48	5.755
common element's	2.30	11.68	6.99
trace element's	16.56	15.89	16.21
Important organic	4.99	8.42	6.71
Flouride contents	4.42	14.97	8.93
Element's comtent	1.75	9.31	5.53
Interrlationg of element's content	3.45	7.51	5.48
Life element content level	2.56	2.60	2.58
Selenium content	37.47	13.41	25.44
Interrelation among element's	1.00	7.78	4.39
Hair Elemental content level	0.31	9.42	4.87
	S=0.4	α=0.5	

C: The comprehensive weight

We used the following equation to synthesize the value weight and the affecting weight, in order to reflect comprehensively the relative importance of each environmental factor in the total environment.

$$W_i = \alpha W_{i1} + (1 - \alpha) W_{i2}$$

in the equation.

W_i —the comprehensive weight,

W_{i1} —the value weight

W_{i2} —the affecting weight,

α —the proportionate factor, $\alpha \in [0, 1]$

We assumed $\alpha = 0.5$ to calculate, the first 7 digits of the comprehensive value are sequentially : selenium content, the amount of trace element, the geologic nature, the water of the well, the content of the common element, the important organic composition, the content of the chemical element in the human hair, for detail see table 2.

References

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