Research on the Assessment of Qingdao Residents through Artificial Intelligence Algorithms and Grey Prediction Model

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Abstract. The model of health level system was constructed based on medical treatment, environment, policy, life and culture in Qingdao, the weight of each index was determined based on entropy method, and the impact of each index on residents' health level was analyzed. Then the comprehensive score of health level was calculated according to the weight of each index. Finally, according to the grey prediction model, the comprehensive score is fitted and predicted, and relevant suggestions are provided according to the fitting and prediction conclusions.

1. Introduction

People's health is an important symbol of national prosperity and national prosperity, prevention and prediction are the most economic and effective health strategies. Recently, the state issued the "Health China Action (2019–2030)" and other relevant documents [1], centering on the two cores of disease prevention and health promotion, and proposed to carry out 15 major special actions to promote the transformation from disease treatment-centered to people's health-centered [2], and strive to make the masses less sick. With the gradual improvement of living standards, people's demand for health services is very pressing. With the support of the policy, China's large health industry has a broad market prospect. However, the current big data on people's health is not optimistic. The data on the total population of diseases and the incidence rate are beyond your imagination. The prevalence of chronic diseases has reached 23%, and the number of deaths accounts for 86% of the total number of deaths. According to big data statistics, on average, one person suffers from cancer every 10 seconds, one person suffers from diabetes every 30 seconds, and at least one person dies of cardiovascular and cerebrovascular diseases every 30 seconds. With the development of science and technology and the Internet, Internet companies represented by Tencent, Baidu and Ali hope to merge information technologies such as mobile Internet and artificial intelligence with big health industries to create new areas. However, the integration of intelligence and people's health is still not perfect, Therefore, it is particularly important to detect and even predict people's health level through artificial intelligence. [3]

With the development of the national economic level, people have higher and higher requirements for the health of life. However, the factors affecting people's health level are very complex. Therefore, it is very important to analyze many factors of people's health level and can offer constructive suggestions on relevant policies.
First of all, from the medical, environmental, policy, life, culture and other aspects to find indicators to build health level evaluation system. In the health level evaluation index system, each evaluation index reflects the influencing factors of people's health level from health care, environmental greening, industrial environment, and residents' life, but their effects on the health level are different. In order to quantify the degree of impact of each index on health level, the objective weight-determining entropy method was used to determine the weight of each index in the health evaluation system. Then, the health level scores of each year were obtained, and the G11 grey prediction model was used to predict the health level of residents in Qingdao in the following years, and the development trend of health level of residents in Qingdao was analyzed quantitatively.

2. Health level evaluation model based on entropy method
Entropy method [4] to determine the weight of each index method is as follows:
First, the raw data matrix was constructed using the values of each research index in Qingdao from 2010 to 2019.

\[
\begin{bmatrix}
2147 & 36066 & \ldots & 432373 \\
2549 & 39980 & \ldots & 510236 \\
\vdots & \vdots & \ddots & \vdots \\
8317 & 60519 & \ldots & 691016.4
\end{bmatrix}
\]

(1)

Second, the data standardization. Since the dimensions of each indicator are different, the data of each indicator should be subjected to dimensionless, non-negative and normalized processing. Depending on the data type, different methods are used for normalization:
Benefit indicators:

\[
R_{ij} = \frac{x_{ij} - \min(x_{1j}, \ldots, x_{nj})}{\max(x_{1j}, \ldots, x_{nj}) - \min(x_{1j}, \ldots, x_{nj})} + 1
\]

(2)

Cost index:

\[
R_{ij} = \frac{\max(x_{1j}, \ldots, x_{nj}) - x_{ij}}{\max(x_{1j}, \ldots, x_{nj}) - \min(x_{1j}, \ldots, x_{nj})} + 1
\]

(3)

After normalization, the values of data of each index were between [1,2], The normalized data matrix:

\[
\begin{bmatrix}
1.0000 & 1.0000 & \ldots & 1.0000 \\
1.0652 & 1.1601 & \ldots & 1.3010 \\
\vdots & \vdots & \ddots & \vdots \\
2.0000 & 2.0000 & \ldots & 2.0000
\end{bmatrix}
\]

(4)

Next, the quotient of each element in the matrix R and the sum of all the elements in the column is calculated, and the matrix P is obtained:

\[
\begin{bmatrix}
0.0697 & 0.0665 & \ldots & 0.0740 \\
0.0742 & 0.0771 & \ldots & 0.0963 \\
\vdots & \vdots & \ddots & \vdots \\
0.1393 & 0.1330 & \ldots & 0.1480
\end{bmatrix}
\]

(5)

And then calculating the entropy value of each index:
\[ E_j = -k \sum_{i=1}^{n} P_{ij} \ln(P_{ij}) \]  

(6)

\( k \) is the adjustment coefficient, \( k = 1/\ln n \), \( n=10 \), entropy matrix:

\[ E = [0.9821 \ 0.9924 \ 0.9890 \ ... \ 0.9896 \ 0.9935 \ 0.9908] \]  

(7)

Then calculating the entropy value redundancy of each index:

\[ D_j = 1 - E_j \]  

(8)

Entropy value redundancy matrix:

\[ D = [0.0179 \ 0.0076 \ 0.0110 \ ... \ 0.0104 \ 0.0065 \ 0.0092] \]  

(9)

Calculate weight through entropy value redundancy:

\[ \omega_j = \frac{D_j}{m \sum_{j=1}^{m} E_j} \]  

(10)

Finally, the weight value of each index was multiplied by the index value to obtain the health level evaluation score in each year. Evaluation model:

\[ U_i = \sum_{j=1}^{m} \omega_j R_{ij} \]  

(11)

3. Model solving

3.1. Health development trends

In order to quantitatively analyze the development trend of health level of residents in Qingdao, the health level scores from 2010 to 2019 were fitted.

In this paper, the annual health level scores of residents from 2010 to 2019 were created as the original sequence:

\[ x_1^{(0)}, x_2^{(0)}, x_3^{(0)} \ ... \ ... x_{10}^{(0)} \]  

(12)

And perform accumulation once to generate a new sequence

\[ x_1^{(1)}, x_2^{(1)}, x_3^{(1)} \ ... \ ... x_{10}^{(1)} \]  

(13)

Among them, \( x_k^{(1)} = \sum_{i=1}^{k} x_i^{(0)}, k = 1,2,3 \ ... \)
A mean sequence is then generated
\[ z_k^{(1)} = \alpha x_k^{(1)} + (1 - \alpha) x_{k-1}^{(1)}, k = 2,3 \ldots \]  

(14)

Next, we establish the first-order one-variable differential equation GM (1,1) for the whitened form of \( t \) according to the gray theory for \( x^{(1)} \):
\[ \frac{dx^{(1)}}{dt} + ax^{(1)} + b, k = 2,3 \ldots \]  

(15)

Where \( a \) and \( b \) are the coefficients to be solved, which are respectively called development coefficient and grey action quantity.

The above formula can be written as a matrix:
\[ \begin{bmatrix} -z_2^{(1)} & 1 \\ \vdots & \vdots \\ -z_{10}^{(1)} & 1 \end{bmatrix} \begin{bmatrix} a \\ b \end{bmatrix} = \begin{bmatrix} x_2^{(0)} \\ \vdots \\ x_{10}^{(0)} \end{bmatrix} \]  

(16)

That is \( X\beta = Y \), the estimated value of the parameter matrix \( \beta \) can be determined by the least square method
\[ \beta = (X^TX)^{-1}X^TY \]  

(17)

From this, the estimated values of the parameters \( a \) and \( b \) are obtained, and the whitening equation is used to obtain the general solution of the sequence \( x_k^{(1)} \):
\[ x_k^{(1)} = \left( x_1^{(0)} - \frac{b}{a} \right) e^{-a(k-1)} + \frac{b}{a}, k = 2,3 \ldots \]  

(18)

Restore to the original series to get the prediction function:
\[ x_k^{(0)} = \left( x_1^{(0)} - \frac{b}{a} \right) e^{-a(k-1)} (1 - e^a), k = 2,3 \]  

(19)

The development trend of health level score was analyzed by G11 gray prediction model [5] with Matlab software, and the result is shown in Figure 1.
3.2. Health level projections and recommendations

The principle of grey prediction is to regard the discrete data scattered on the time axis as a series of continuous changes, adopt the method of accumulation and accumulation and reduction, weaken the unknown factors in the grey system and strengthen the influence degree of the known factors. Finally, a continuous differential equation with time as a variable is constructed, and the parameters in the equation are determined by mathematical method, so as to achieve the purpose of prediction.

Through the G11 grey prediction model analysis of Qingdao residents' health level score in three years after Figure 2:

![Figure 1. Development trend of health level in Qingdao City from 2010 to 2019](image1)

![Figure 2. Health level scores of Qingdao residents in three years after 2019](image2)

According to the impact of each indicator, the values of some indicators in 2019 were optimized to calculate the scores of residents' health level [6] under this indicator, as shown in Table 2.
Table 2. Improved values of each index in health level assessment model

| Specific indicators                                      | Occurrence       |
|---------------------------------------------------------|------------------|
| Number of Health Institutions X1                        | 8317->10000      |
| Number of Beds X2                                       | 60519->75000     |
| Health technical personnel number X3                    | 90361->100000    |
| Total number of special vehicles for city appearance and environmental sanitation X4 | 5406             |
| Domestic garbage harmless treatment energy X5           | 11500            |
| Green area X6                                           | 40844->45000     |
| Number of Parks X7                                      | 192->205         |
| Total sulfur dioxide emissions X8                       | 13916.78->10000.58 |
| Total nitrogen oxide emissions X9                       | 2391.09->2000.03 |
| Total Smoke (Powder) Dust Emission X10                  | 12907.66         |
| Number of Waste Gas Treatment Facilities X11            | 2794             |
| Total industrial waste gas emissions X12                | 42925879.90      |
| Urban air quality good rate X13                         | 78.60            |
| Per capita disposable income of urban residents X14     | 54484            |
| Urban per capita consumer spending X15                  | 35266            |
| City residents per capita housing construction area X16 | 31.90            |
| Urban engel coefficient X17                             | 28.2             |
| Domestic tourism revenue X18                            | 1897.2           |
| Total resident deposits X19                             | 172829678->20000000 |
| Catering industry turnover X20                          | 691016.4         |

Among these indicators, the research efficiency indicators have a positive impact on residents' health scores, and the research cost indicators have a negative impact on residents' health scores. The data queried from 2010 to 2019 indicated that the indicator data fluctuated annually, and the indicator value in 2019 was further optimized according to the weight of each indicator. The newly obtained health level is shown in Fig.3, and the trend from 2019 to 2020 can be predicted. Compared with the fitting trend of grey prediction from 2010 to 2019, it can be found that the development trend of health level by each index after improvement has a significant increase.

Figure 3. Health scores of Qingdao residents from 2010 to 2019 after optimization of indicators
4. Conclusion
According to the evaluation results of health level in Qingdao city, we should increase the number of health institutions and parks and the training of health technical personnel. At the same time should be limited to the majority of industrial enterprises, and vigorously promote the use of no harm to the environment of the fuel, so as to reduce the damage to the ecological environment. While total emissions of sulfur dioxide and nitrogen oxide emissions should be reduced. In the final index of the people's disposable income, we can clearly see that its weight is very small, that is to say, it does not have a great impact on the people's health level, so we can not blindly pursue the improvement of the economic level, we should focus on the ecological environment and the economic level, and make common progress, so as to improve the people's health level.

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