

# Evaluating the Quality of Medical and Health Services by the Method of Topsis and Linear Interpolation in China

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**Keywords:** Medical Service, TOPSIS Method, Linear Interpolation Method.

**Abstract:** This study aims to use of TOPSIS method and linear interpolation method to evaluate the work of medical services in towns and townships, to understand our country in various provinces, cities and towns and townships, 2016 medical and health services status quo, analysis of regional differences. This study selected reflected in towns and townships to medical service quality of six indicators, using TOPSIS method and linear interpolation method in various provinces and cities in the country towns and townships is used to evaluate medical service quality. Using the SPSS 17.0 software to the ranking results of two methods to do Spearman correlation analysis and Kruskal Wallis H test. The Spearman correlation analysis and TOPSIS method and the linear interpolation method, the correlation of evaluation results is higher ( $r = 0.915$ ,  $P = 0.000$ ). Two kinds of comprehensive evaluation results sorting, sichuan, henan, guangxi is located in the top three, shanxi, Inner Mongolia, jilin, after three. Thus this research conclusions: regional differences in towns and townships throughout the country medical service quality, two kinds of evaluation results is highly correlation.

## 1 INTRODUCTION


In towns and townships as an important part of the basic health service system construction, burdened with a large number of medical and health services, epidemic prevention, such as maternity care work, in the protection of peasants health plays an important role of (Gao 2018). Although grassroots health workers are accelerating in China, has a certain regional differences. In towns and townships of our country is used to evaluate medical service quality is of great significance to the evaluation result directly reflect the grassroots medical service level. At present, the TOPSIS method is limited in systems engineering solution of multi-objective decision analysis is a kind of commonly used method, often used for quality evaluation work of medical institutions, advantage is that can make full use of original data information, sorting results intuitive and reliable (Liu, Chai, Xu, Cai 2018); Linear


interpolation method, according to the average index of minor sort method is simple, convenient application, the differences due to different evaluation method and evaluation results, in order to ensure objectivity of evaluation results, this study adopts the TOPSIS method, linear interpolation method is used to evaluate the national basic medical service quality, in order to understand our country in various provinces, cities and towns and townships, 2016 service present situation and analyzes the regional differences.


## 2 DATA AND METHODS

### 2.1 Source

This research uses the data of national health and family planning commission, "2017 China statistical yearbook of health and family planning (National health and family planning commission 2017).

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## 2.2 Index Selection

Refer to the China statistical yearbook of health and family planning of towns and townships health service category, select six representative indicators of 29 provinces in China in 2016 (the data does not include Beijing, Shanghai) is used to evaluate the towns and townships of medical service quality. Selected indicators are: X1 - sickbed utilization rate (%), X2 - average (day) of such confinement, X3 - physicians daily for visits, X4 - physicians daily for hospital bed, X5 - visits (ten thousand people), X6 - admissions (ten thousand people). Among them, the X2 - low average such confinement for optimal index, the rest for the yields and indicators.

## 2.3 Comprehensive Evaluation Method

### 2.3.1 TOPSIS Method

TOPSIS method is based on the normalized after the original data matrix, calculated to evaluate solutions and the optimal scheme and the worst, according to the size of the relative distance evaluation using a method (Wang, Song, An 2015). list the decision matrix, namely the original data set: 29 provinces, six indicators, form a comprehensive evaluation of the original data table, as shown in table 1. index with chemokines normalization processing:  $100 / (x)$  by inverse method yields and index, low optimal index can be converted to realize with chemokines, further normalization processing eliminate the influence of discrete tendency and normalized matrix values(1):to determine the optimal worst plan:  $Z^+ = (0.31, 0.28, 0.38, 0.42, 0.52, 0.44)$ ,  $Z^- = (0.05, 0.01, 0.05, 0.01, 0.01, 0.01)$ ;  $D^+$ ,  $D^-$  and proximity  $C_i$ : each evaluation objects and the distance  $Z^+$ ,  $Z^-$  to  $D^+$ ,  $D^-$ , proximity to  $C_i$ ,  $C_i$  is close to 1, medical services, the better the results(2). sorting: according to the  $C_i$  value from big to small order, get medical service level of provinces and cities, sort the results, as shown in table 2.

$$Z'_{ij} = \frac{f_{ij}}{\sqrt{\sum_{i=1}^n f_{ij}^2}} \quad (1)$$

$$D_i^+ = \sqrt{\sum_{j=1}^m (Z'_{ij} - Z_j^+)^2}, \quad D_i^- = \sqrt{\sum_{j=1}^m (Z'_{ij} - Z_j^-)^2},$$

$$i = 1, \dots, n, \quad C_i = \frac{D_i^-}{D_i^+ + D_i^-},$$

$$0 \leq C_i \leq 1, i = 1, \dots, n \quad (2)$$

### 2.3.2 Linear Interpolation Method

Linear interpolation method is essentially actual value evaluation of each index in the index is the ratio of the location in the whole distance, finally according to the evaluated object average minor sort, (0,1), the bigger value shows that comprehensive evaluation result more optimal (Li, Wang, Xia, Zhang, Bai 2015).

Rank: the minimum and maximum parameter values will be integers, the rest are basically as a integer. The yields and indicators:(3). For low optimal indicators: (4).

Calculated the comprehensive rank (5).

The sorting: by RSR values from big to small order, comprehensive evaluation results by linear interpolation method, shown in table 4.

$$R = 1 + (n - 1) \frac{X - X_{\min}}{X_{\max} - X_{\min}} \quad (3)$$

$$R = 1 + (n - 1) \frac{X_{\max} - X}{X_{\max} - X_{\min}} \quad (4)$$

$$RSR_i = \sum_{j=1}^m \frac{R_{ij}}{m \times n} \quad (5)$$

## 2.4 Statistical Analysis Methods

SPSS 17.0 software was used to deal with the data analysis.  $\alpha = 0.01$ .

## 3 RESULTS

### 3.1 Primary Care Services

Regional differences in towns and townships health service indicators. Hubei province in towns and townships sickbed utilization rate is as high as 76.70%, followed by chongqing, xinjiang, Tibet autonomous region sickbed utilization rate, the lowest is 28.30%; The highest average such confinement was in towns and townships, zhejiang province, is 9.1 days, followed by Shanxi Province and jiangsu province. Physician burden of daily visits are highest in Shanghai, followed by the zhejiang province, tianjin, the lowest is Tibet; Physicians daily for visits are highest in zhejiang province, the second is in yunnan province and hainan province. Physicians, xinjiang province, the highest average daily take such confinement was followed by chongqing municipality, sichuan province. In towns and townships, 2016 visits the most were in henan province, was hospitalized people most is sichuan province, as shown in the table 1.

Table 1: Provinces of original index in towns and townships medical services.

Area	X1	X2	X3	X4	X5	X6
Tianjin	44.00	7.50	11.70	0.80	645.94	7.22
Hebei	58.50	7.20	7.40	1.40	4777.19	168.67
Shanxi	35.10	8.50	6.70	1.10	1603.68	42.65
Inner Mongolia	42.20	6.50	5.50	0.90	1217.01	36.28
Liaoning	44.30	7.60	8.00	1.50	1718.16	55.25
Jilin	28.80	7.50	4.70	0.60	967.24	1.76
Heilongjiang	56.60	6.30	4.80	1.45	983.28	66.56
Jiangsu	63.60	7.60	10.90	1.10	8288.55	163.38
Zhejiang	49.70	9.10	18.00	0.40	9351.85	30.69
Anhui	60.60	6.60	8.80	1.40	4576.62	157.95
Fujian	49.50	6.10	11.00	1.40	2702.97	82.14
Jiangxi	68.70	5.40	8.90	2.20	3228.70	201.88
Shandong	60.70	7.30	7.50	1.50	7331.87	273.53
Henan	62.20	7.20	12.50	1.70	11218.47	287.33
Hubei	76.70	7.00	8.10	1.80	5755.85	258.67
Hunan	70.50	6.00	4.60	1.80	4046.01	373.03
Guangdong	55.20	5.30	8.70	1.00	6690.25	194.48
Guangxi	63.30	5.20	12.00	2.20	5132.05	252.32
Hainan	33.30	6.50	16.50	0.60	1149.72	7.72
Chongqing	74.10	6.70	7.60	2.80	2002.69	153.74
Sichuan	70.70	6.30	11.50	2.50	9372.06	443.28
Guizhou	44.90	4.90	8.70	1.40	2661.97	119.63
Yunnan	53.40	5.80	17.80	2.10	5087.92	140.96
Xizang	28.30	5.00	13.40	0.60	413.63	3.70
Shaanxi	46.60	7.30	9.00	1.60	2202.58	75.43
Gansu	60.00	6.40	8.90	1.50	2006.48	67.76
Qinghai	55.10	5.50	6.10	1.20	258.76	11.49
Ningxia	49.10	6.60	13.70	0.60	670.59	4.88
Xinjiang	74.00	6.10	12.90	2.80	2170.96	101.67

### 3.2 TOPSIS Method to Comprehensive Evaluation Results

We Used TOPSIS comprehensive evaluation method of 29 provinces, cities and towns and townships of six measures of service. The results are shown in

table 2, the medical service level in the top three, guangxi, henan, sichuan, after three, respectively, shanxi, jilin, Inner Mongolia.3.3. Status quo of incentive satisfaction of urban community nurses in Shandong Province. evaluation results.

Table 2: Based on TOPSIS method of job evaluation in towns and townships of medical services.

Area	D+	D-	Ci	The sorting
Sichuan	0.151	0.666	0.8151	1
Henan	0.249	0.573	0.6970	2
Guangxi	0.340	0.435	0.5618	3
Shandong	0.350	0.436	0.5549	4
Hunan	0.394	0.477	0.5480	5
Hubei	0.365	0.421	0.5357	6
Jiangsu	0.408	0.399	0.4940	7
Yunnan	0.418	0.403	0.4908	8
Guangdong	0.422	0.359	0.4598	9
Jiangxi	0.440	0.365	0.4530	10
Zhejiang	0.546	0.431	0.4410	11
Xinjiang	0.516	0.378	0.4232	12
Chongqing	0.511	0.370	0.4202	13
Hebei	0.469	0.298	0.3887	14

Anhui	0.468	0.296	0.3876	15
Tianjin	0.686	0.381	0.3573	16
Guizhou	0.542	0.238	0.3053	17
Fujian	0.556	0.225	0.2878	18
Jiangsu	0.586	0.212	0.2654	19
Shaanxi	0.581	0.204	0.2603	20
Hainan	0.678	0.219	0.2445	21
Liaoning	0.616	0.172	0.2183	22
Heilongjiang	0.637	0.178	0.2183	23
Ningxia	0.686	0.181	0.2090	24
Xizang	0.703	0.185	0.2085	25
Qinghai	0.691	0.152	0.1799	26
Shanxi	0.656	0.115	0.1489	27
Jilin	0.730	0.041	0.0527	28
Inner Mongolia	0.673	0.037	0.0518	29

### 3.3 Linear Interpolation Method, Comprehensive Evaluation Results

According to the mean value of each evaluation index of provinces and cities, minor sort, the results

show that the sorting is located in the top three, respectively is sichuan, guangxi, henan, and after the three were in Inner Mongolia, shanxi, jilin, as shown in the table 3.

Table 3: Based on the linear interpolation method, the average size of minor sort of job evaluation in towns and townships medical services.

Area	X1	X2	X3	X4	X5	X6	P	The sorting
Sichuan	25.53	19.67	15.42	25.50	24.28	29.00	0.80	1
Guangxi	21.25	27.00	16.46	22.00	13.45	16.89	0.67	2
Henan	20.61	13.67	17.51	16.17	29.00	19.11	0.67	3
Yunnan	15.52	23.00	28.58	20.83	13.34	9.83	0.64	4
Xinjiang	27.44	21.00	18.34	29.00	5.89	7.34	0.63	5
Jiangxi	24.37	25.67	9.99	22.00	8.59	13.69	0.60	6
Hubei	29.00	15.00	8.31	17.33	15.04	17.29	0.59	7
Hunan	25.41	21.67	1.00	17.33	10.68	24.54	0.58	8
Chongqing	27.50	17.00	7.27	29.00	5.46	10.64	0.56	9
Guangdong	16.56	26.33	9.57	8.00	17.43	13.22	0.52	10
Shandong	19.74	13.00	7.06	13.83	19.07	18.23	0.52	11
Jiangsu	21.42	11.00	14.16	9.17	21.51	11.25	0.51	12
Anhui	19.69	17.67	9.78	12.67	12.03	10.90	0.48	13
Guizhou	10.60	29.00	9.57	12.67	7.14	8.47	0.45	14
Hebei	18.47	13.67	6.85	12.67	12.54	11.58	0.44	15
Fujian	13.26	21.00	14.37	12.67	7.24	6.10	0.43	16
Gansu	19.34	19.00	9.99	13.83	5.47	5.19	0.42	17
Jiangsu	13.38	1.00	29.00	1.00	24.23	2.83	0.41	18
Shaanxi	11.59	13.00	10.19	15.00	5.97	5.67	0.35	19
Heilongjiang	17.37	19.67	1.42	13.25	2.85	5.11	0.34	20
Qinghai	16.50	25.00	4.13	10.33	1.00	1.62	0.34	21
Ningxia	13.03	17.67	20.01	3.33	2.05	1.20	0.33	22
Hainan	3.89	18.33	25.87	3.33	3.28	1.38	0.32	23
Xizang	1.00	28.33	19.39	3.33	1.40	1.12	0.31	24
Liaoning	10.26	11.00	8.10	13.83	4.73	4.39	0.30	25
Tianjin	10.08	11.67	15.84	5.67	1.99	1.35	0.27	26
Inner Mongolia	9.04	18.33	2.88	6.83	3.45	3.19	0.25	27
Shanxi	4.93	5.00	5.39	9.17	4.44	3.59	0.19	28
Jilin	1.29	11.67	1.21	3.33	2.81	1.00	0.12	29

### 3.4 Correlation Analysis

The ranking results of two comprehensive evaluation methods are the same, On the results of regional sorting the raw data. Completely random design of Kruskal Wallis H - inspection, the result shows that the difference in the ranking results of two kinds of evaluation methods has no statistical significance. Further do Spearman correlation analysis, the result of the evaluation shows that the ranking results of two kinds of evaluation methods have high correlation ( $r=0.915$ ,  $P<0.01$ ), as shown in the table 4.

Table 4: Two kinds of Spearman correlation analysis of the evaluation results.

	TOPSIS method	linear interpolation method
TOPSIS method	1.000	0.915
linear interpolation method	0.915	1.000

### 3.5 Two Kinds of Evaluation Results of Correlation Analysis

Two kinds of evaluation results is not the same, to ensure the accuracy and objectivity of the evaluation results, the results of the two evaluation methods show comprehensive sequencing, the results showed that the country towns and townships of medical service quality of the top three provinces, guangxi, henan, sichuan, those in the bottom three of shanxi, Inner Mongolia, jilin, respectively. As shown in the table 5.

Table 5: Based on two methods of evaluation of comprehensive sorting table in towns and townships of medical services.

Area	TOPSIS method	linear interpolation method	The average sort	The comprehensive sequencing
Sichuan	1	1	1.00	1
Henan	2	3	2.50	2
Guangxi	3	2	2.50	2
Yunnan	8	4	6.00	3
Henan	5	8	6.50	4
Hubei	6	7	6.50	4
Shandong	4	11	7.50	5
Jiangxi	10	6	8.00	6
Xinjiang	12	5	8.50	7
Jiangsu	7	12	9.50	8
Guangdong	9	10	9.50	8
Chongqing	13	9	11.00	9

Anhui	15	13	14.00	10
Zhejiang	11	18	14.50	11
Hebei	14	15	14.50	11
Guizhou	17	14	15.50	12
Fujian	18	16	17.00	13
Gansu	19	17	18.00	14
Shaanxi	20	19	19.50	15
Tianjin	16	26	21.00	16
Heilongjiang	23	20	21.50	17
Hainan	21	23	22.00	18
Ningxia	24	22	23.00	19
Liaoning	22	25	23.50	20
Qinghai	26	21	23.50	20
Xizang	25	24	24.50	21
Shanxi	27	28	27.50	22
Inner Mongolia	29	27	28.00	23
Jilin	28	29	28.50	24

## 4 CONCLUSIONS

### 4.1 Comprehensive Evaluation Results

At present, the urban grassroots medical and health service system is steady and rapid development, but there are still areas development speed and scale imbalance problem. Comprehensive evaluation results from the above, our country towns and townships in the central region the low level medical service quality, this is consistent with the result of actor of (Liu 2013). Among them, the medical service quality comprehensive ranking top three, respectively is, guangxi, henan, sichuan, after three shanxi, Inner Mongolia, jilin, respectively.

Sichuan, henan, guangxi region in towns and townships of medical service quality is good, is located in the top level. Sichuan towns and townships comprehensive medical service quality is best, high on the first bit admissions index; The number of physician practice in henan and admission number is located in the country first and third respectively. In towns and townships of shanxi, Inner Mongolia, jilin region after comprehensive ranking in the national health service ability. Hospital in jilin people located in all but 1, sickbed utilization rate, average daily visits and professionals, average daily for hospital beds per second from bottom in the country. Grassroots health work in recent years, the rapid development in our country, but the regional conditions and policy environment to a certain extent, affect the operation of the medical and health work and development. Some less developed areas of fiscal investment is insufficient, compensation mechanism

is imperfect, the government health work value degree is low, lead to the low level of health manpower, equipment and funds, weak grassroots service capacity (Xue 2014). So, in order to improve the basic health service ability, improve the grassroots health development of the regional imbalance, local governments should improve attention to grassroots health work, increase policy support and financial support. Central policy tilt in less developed areas should be targeted to the economy, to strengthen the construction of infrastructure, the rational allocation of health resources, perfect the incentive mechanism, to provide economic underdeveloped regions in health manpower and material resources, and promote the equal basic health services.

#### 4.2 The Application Value of the Two Kinds of Evaluation Method

The combination of two kinds of evaluation methods, can be more intuitive, accurately reflect the regional grassroots medical service level (Ying, Liu, Zhao, Wang, Sa, LI 2016). By Spearman correlation analysis, according to two kinds of results correlation is higher, the correlation coefficient were statistically significant. Although the two kinds of evaluation results, but the difference was not significant, examined the Kruskal Wallis H - and there was no statistically significant difference of the two kinds of evaluation result, and the results have good consistency. In this paper, research results are accurate, can reflect the regional differences of the basic medical service quality.

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