

Study on the relationship between the richness and utilization efficiency of health manpower resources

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ABSTRACT

This paper studies whether there is a correlation between the richness of health manpower resource and the utilization efficiency of health resources. The number of health workers per thousand people was used to measure the richness of health manpower resources, and the BCC model of data envelopment analysis was used to calculate the relative health resource utilization efficiency of all cities in Hubei in 2019. To explore the correlation between the richness of health manpower resources and the utilization efficiency of health resources clearly, the correlation test was carried out. The results showed that the utilization efficiency of health resources was negatively correlated with the richness of health human resources in 15 cities except Wuhan, the provincial capital city, and Shennongjia. Therefore, it is considered that the richness of health manpower resources has an impact on the utilization efficiency of health resources, which may form a “resource curse”, that is, the richness of resources may lead to the inefficient utilization of resources. It is suggested that the government should introduce policies to control the number of health workers in cities with low utilization efficiency and high resource abundance, encourage medical graduates to find jobs in cities which equipped with less health workers and high utilization, guarantee the health manpower in areas with less health workers, and promote the harmonious and balanced development of the whole province.

Keywords: Health manpower resources richness, utilization efficiency, correlation

1. INTRODUCTION

With the improvement of economic level, the health industry has been fully developed, and the health industry personnel have been fully equipped, but the people’s demand for health is also increasing. At present, significant progress has been made in the development of China’s medical and health undertakings, but there are still some problems, such as unbalanced structure, unreasonable distribution between urban and rural areas, malposition between medical and health system construction and medical demand¹, which make the use efficiency of hygiene resources low and affect the realization of health equity and health equality.

Lots of scholars have done a lot of research on the allocation efficiency and utilization efficiency of medical resources in various regions. Some scholars have used basic models of data envelopment analysis (DEA) and DEA Malmquist model to measure the pure technical efficiency and total technical efficiency of health resources. Some scholars also adopted Tobit model to study the influencing factors of utilization efficiency. Yang² used DEA basic model and Malmquist index to figure out the efficiency and productivity of traditional Chinese medicine hospitals in various regions, and then used Tobit model to figure out the influencing elements of efficiency. It was found that the total factor productivity of traditional Chinese medicine hospitals showed a downward trend, financial allocation had impacts on the comprehensive efficiency, and scientific research and education had impacts on the technical efficiency. Fan³ also used DEA basic model to analyze the allocation efficiency of health resources of 14 cities in Guangxi in 2015 and 2018, and the health resources of Guangxi in 2010-2018. It was considered that there existed some irrationalities in the distribution of health resources in Guangxi, such as insufficient utilization efficiency and unreasonable scale. It is essential to further improve the management level and optimize the allocation structure to improve the distribution efficiency of health resources.

However, in the field of health, few scholars have investigated the relationship between the richness of health manpower resources and the utilization efficiency of health resources. This paper explores whether there is a correlation between the richness of health manpower resources and the utilization efficiency of health resources from a new perspective.

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2. DATA SOURCES AND ANALYSIS METHODS

2.1. Sources of data

In this study, there are 17 cities in Hubei. Wuhan is the provincial capital, accounting for 17.88% of the population. Shennongjia has the least population, accounting for 0.13% of the population. The data of medical resources in each city are from 2019 health statistical yearbook of Hubei. The population of each city comes from the 2019 Statistical Yearbook published on its official website, and uses the number of permanent residents at the end of the year as the population data.

2.2. Analysis methods

2.2.1. The richness of health manpower resources. In the past, scholars used the number of health manpower resources per thousand people as an indicator when measuring the abundance of health manpower resources in a region. This paper mainly explores whether there is a correlation between the distribution of health manpower resources and the use efficiency of health resources. Therefore, the health statistical index “the number of health technicians per thousand” is selected to measure the richness of health manpower resources.

2.2.2. Data envelopment analysis. DEA was first put forward by American scientists Charnes, Cooper and Rhodes in 1978⁴. Therefore, the original DEA model was named CCR model, which calculates the comprehensive technical efficiency of input and output under the assumption of constant returns to scale (CRS).

DEA is a nonparametric statistical analysis method based on input and output data to evaluate the relative effectiveness of efficiency. It has absolute advantages in multi input and multi output data evaluation, and has been widely used in the field of medical and health efficiency evaluation⁵.

In the evaluation of hospital resource allocation efficiency, the BCC model in DEA adjusts the assumption of constant returns to scale in CCR model. On the premise of variable returns to scale, the comprehensive technical efficiency is further decomposed into the product of pure technical efficiency and scale efficiency. The BCC model can provide the relative efficiency and returns to scale among decision-making units. Based on the investigation of the efficiency of previous studies⁶⁻¹⁰, this paper calculates the utilization efficiency of health resources. The input indicators selected are the number of institutions, the number of beds and the number of health technicians, and the output indicators are the number of diagnosis and treatment (10000 times) and the number of inpatient surgeons.

2.2.3. Statistical methods. In this paper, the richness of health manpower resources is calculated by Excel, and the use efficiency of health resources is calculated by deap 2.1 software. When testing the relationship between the richness and utilization efficiency, SPSS software is used for Spearman rank correlation and correlation coefficient test.

3. RESULT AND DISCUSSION

3.1. Basic situation of medical and health resources allocation and service capacity in cities of Hubei

After consulting 2019 health yearbook of Hubei, there were 35479 medical and health institutions, 406469 beds and 529813 health personnel in Hubei Province in 2019.

The health personnel include 419518 health technicians. Among the health technical personnel, 155025 were licensed doctors or licensed assistant doctors, accounting for 36.95%, 195852 were registered nurses, accounting for 46.68%, 18731 were pharmacists, accounting for 4.46%, 21386 were technicians, accounting for 5.10%, and 28524 were interns or other identities, accounting for 6.90%. In 2019, the total number of diagnosis and treatment in Hubei is 354.79 million, and the total number of operations carried out by inpatients is 3.687 million. Wuhan, the provincial capital, had the largest number of doctors and inpatients. The specific number of institutions, number of beds, number of health technicians, total number of doctors and patients, and number of operations carried out by inpatients in each city are as follows, as shown in Table 1.

3.2. Analysis on utilization efficiency of medical resources in cities of Hubei

With the help of output oriented BCC model, this study analyzes the utilization efficiency of medical resources in all cities of Hubei Province in 2019. The input index is the number of institutions, the number of beds, the number of health technical personnel, and the output index is the number of diagnosis and treatment (10000 times), the number of inpatient surgery. After sorting out the input-output index data, put the output index in the front and the input index in the back, put the data

in the text document, and use the deap 2.1 software to calculate the comprehensive technical efficiency under the CRS radial dea-BCC model. The parameter settings in the software are shown in Figure 1.

Table 1. Basic medical allocation and services in different cities of Hubei.

Serial number	City	Number of institutions	Actual number of beds	Total health personnel	Person time of diagnosis and treatment (10000 times)	Operation times of inpatients
	Total	35479	406469	529813	35479	3687095
1	Wuhan	4913	96357	141778	9113	1215251
2	Huangshi	1443	17767	25029	1276	141357
3	Shiyan	2772	30634	35038	2354	273234
4	Yichang	2664	29122	39174	2535	244549
5	Xiangyang	3645	39278	44871	3359	378991
6	Ezhou	490	5664	8276	509	28968
7	Jingmen	1923	18923	23801	1647	183231
8	Xiaogan	2311	25632	33839	2128	187613
9	Jingzhou	3156	32706	42440	3094	225337
10	Huanggang	3854	38218	42261	2945	201638
11	Xianning	1345	15760	22560	1399	102845
12	Suizhou	1330	12342	15196	1010	95178
13	Enshi	2947	25408	30139	1777	223145
14	Xiantao	857	6161	8567	224	62183
15	Qianjiang	722	4948	8396	134	55454
16	Tianmen	1035	7064	7758	198	65566
17	Shennongjia	72	485	690	17	2555

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123.txt      DATA FILE NAME
123out3.txt  OUTPUT FILE NAME
17          NUMBER OF FIRMS
1           NUMBER OF TIME PERIODS
2           NUMBER OF OUTPUTS
3           NUMBER OF INPUTS
0           0=INPUT AND 1=OUTPUT ORIENTATED
1           0=CRS AND 1=VRS
0           0=DEA(MULTI-STAGE), 1=COST-DEA,
2=MALMQUIST-DEA, 3=DEA(1-STAGE), 4=DEA(2-STAGE)

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Figure 1. Parameter setting of data envelopment analysis.

The results of comprehensive technical efficiency (CTE), pure technical efficiency (PTE) and scale efficiency (SE) calculated by the software are shown in Table 2. On the whole, the average of CTE, PTE and SE of medical resources in Hubei are 0.909, 0.951 and 0.957 respectively, all of which are greater than 0.9, indicating that the overall utilization efficiency of health resources in Hubei will be in a high state in 2019. It can be considered that the use efficiency of health resources in Wuhan, Xiangyang, Jingzhou and Tianmen cities has reached an effective utilization state, and multiple inputs have been fully utilized.

3.3. Correlation analysis of health personnel richness and medical resource utilization efficiency in different cities of Hubei

According to the allocation of health resources in all city, the richness of health manpower in 17 cities of Hubei is ranked as follows, and the specific allocation is shown in the following table.

Table 2. Comprehensive technical efficiency, pure technical efficiency and scale efficiency of each city.

Serial number	City	Comprehensive technical efficiency	Pure technical efficiency	Scale efficiency
1	Wuhan	1.000	1.000	1.000
2	Huangshi	0.759	0.772	0.983
3	Shiyan	0.907	0.910	0.997
4	Yichang	0.920	0.924	0.996
5	Xiangyang	1.000	1.000	1.000
6	Ezhou	0.950	0.997	0.953
7	Jingmen	0.963	0.972	0.990
8	Xiaogan	0.886	0.890	0.995
9	Jingzhou	1.000	1.000	1.000
10	Huanggang	0.965	0.965	1.000
11	Xianning	0.938	0.951	0.987
12	Suizhou	0.968	0.987	0.980
13	Enshi	0.878	0.880	0.998
14	Xiantao	0.950	0.971	0.978
15	Qianjiang	0.889	0.943	0.942
16	Tianmen	1.000	1.000	1.000
17	Shennongjia	0.477	1.000	0.477

The higher the value is, the lower the richness of manpower resources is. The higher the utilization efficiency is, the lower the utilization efficiency is. The relative efficiency values of each city are classified (Table 3).

The health manpower resource richness of each city was matched with the efficiency level of the city. The health manpower resource richness of each city was ranked as X, and the resource utilization efficiency level was y. The scatter diagram is as follows, as shown in Figure 2.

According to the distribution of scatter diagram, it can be seen that the distribution of other groups is negatively correlated except Wuhan and Shennongjia.

Considering that Wuhan is the provincial capital city, hospitals in other cities will refer patients with difficult diseases to higher hospitals, so the output index of Wuhan is quite high, and the level of resource utilization efficiency is also high. Shennongjia is a national nature reserve with a small population and relatively few health resources compared with other cities. The pure technical efficiency of the city is 1, but the scale efficiency is only 0.477, which leads to the comprehensive technical efficiency of only 0.477, indicating that the efficiency value of the city is special. Therefore, Wuhan and Shennongjia two special cities are eliminated and analyzed. The scatter diagram is shown in Figure 3, which shows that there exists a significant negative correlation.

Table 3. Allocation and efficiency ranking of health resources in each city.

Serial number	City	Comprehensive technical efficiency	Number of health technicians per thousand	Ranking of technical efficiency	Ranking of manpower resource richness
1	Wuhan	1	1018.6	1	1
2	Huangshi	0.759	805.2	16	3
3	Shiyan	0.907	837.5	12	2
4	Yichang	0.92	773.1	11	4
5	Xiangyang	1	607.9	2	10
6	Ezhou	0.95	606.7	8	11
7	Jingmen	0.963	666.7	7	12
8	Xiaogan	0.886	536.7	14	13
9	Jingzhou	1	589.0	3	8
10	Huanggang	0.965	511.1	6	15
11	Xianning	0.938	705.9	10	5
12	Suizhou	0.968	500.1	5	16
13	Enshi	0.878	705.0	15	6
14	Xiantao	0.95	530.0	9	14
15	Qianjiang	0.889	668.7	13	7
16	Tianmen	1	477.3	4	17
17	Shennongjia	0.477	657.0	17	9

The purpose of this study is to explore whether there is a correlation between urban manpower resource richness and utilization efficiency, so we use SPSS software and Spearman rank correlation to analyze the richness of manpower resources and the utilization efficiency. The results are as follows, as shown in Figure 4.

From the above results, we can see that the correlation coefficient R between the two is -0.618 , and the probability value P of the test statistic of the correlation coefficient is 0.014 . Generally, it is considered that $|R| \geq 0.8$ is highly correlated; $0.5 \leq |R| < 0.8$ is significant correlated; $0.3 \leq |R| < 0.5$ is in a low correlation. $|R| < 0.3$ means the relationship between two is very weak, and it is also considered that there is no correlation¹¹. Therefore, it can be considered that there exists a significant negative correlation between manpower resource richness and utilization efficiency at 0.05 significant level¹².

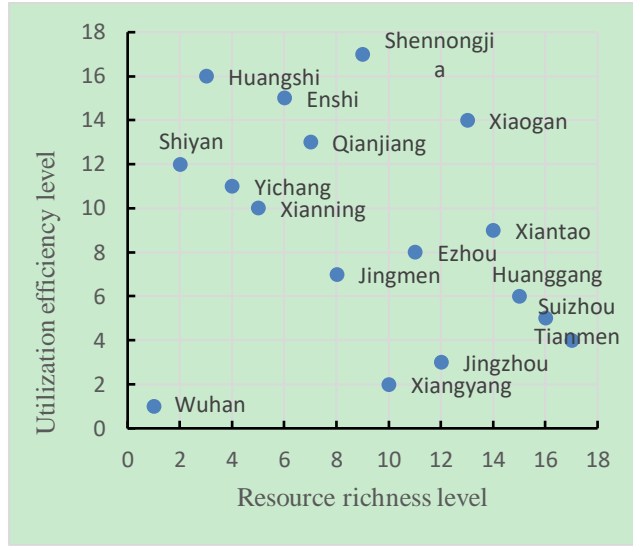


Figure 2. Distribution of health resources and utilization efficiency in different cities.

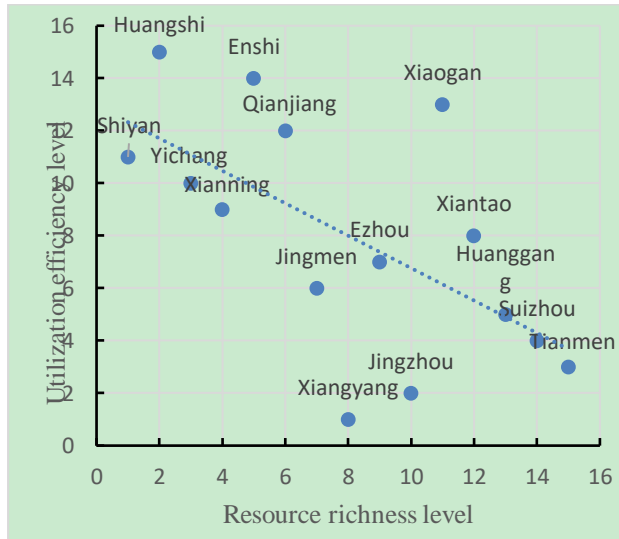


Figure 3. Distribution of health resources and utilization efficiency in different cities.

Correlations

			VAR00001	VAR00002
Spearman's rho	VAR00001	Correlation Coefficient	1.000	-.618*
		Sig. (2-tailed)	.	.014
		N	15	15
	VAR00002	Correlation Coefficient	-.618*	1.000
		Sig. (2-tailed)	.014	.
		N	15	15

*. Correlation is significant at the 0.05 level (2-tailed).
 (var00001 is the level of human resource richness and var00002 is the level of utilization efficiency)

Figure 4. Test results of the correlation between resource richness and utilization efficiency.

5. CONCLUSIONS

In this paper, we calculated the relative efficiency of medical resources utilization among cities and ranked them; And the health manpower resources of each city were measured and ranked. After the correlation analysis, it was found that there was a significant correlation between the richness of health manpower resources and resource utilization efficiency, which was negative correlation, and the correlation degree was moderate correlation. That is to say, the utilization efficiency of cities with lower health manpower resource richness tends to be higher, while that of cities with higher health manpower resource richness tends to be lower. In this paper, we only discuss the correlation, and need to further study whether there is causality. The utilization efficiency of health resources is affected by many factors, and the number of health manpower resources may be one of influencing factors.

According to the analysis of the research results, the following viewpoints are obtained.

First, Wuhan is a super large provincial capital city, which has gathered rich medical resources and attracted a large number of people. It is the diagnosis and treatment center of difficult and miscellaneous diseases. Patients with difficult and miscellaneous diseases who are difficult to cure in grass-roots counties and cities, and severe patients with high surgical difficulty and risk will be referred to the top three hospitals in Wuhan. Therefore, the medical resources of Wuhan have been fully utilized.

Second, the medical resources of non capital cities with high health manpower resources are not fully utilized. The utilization efficiency of medical resources in cities with low health manpower resources is relatively sufficient. In the allocation of medical personnel, the cities with low health manpower resources are supposed to be inclined with more workers. So as to improve the utilization efficiency of medical resources in each city, it is necessary to transfer health talents to the cities which are not rich in health manpower resources. The medical resources in cities with insufficient resources should be fully supplemented.

Third, there may also be a “resource curse” phenomenon in the field of health. The more abundant the resources are, the lower the utilization efficiency will be. In terms of resource allocation, the cities with high utilization efficiency and low resource richness should be inclined, and the number of health personnel in cities with low utilization efficiency and high resource richness should be controlled. The state should carry out macro-control and introduce policies to encourage medical graduates to find jobs in cities which equipped with less health workers and high utilization, so as to make effective use of urban resources and waste can be avoided.

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