Research on the Operational Efficiency of Chinese Medical Institutions Based on the Three-Stage DEA——Malmquist Index Model

Tong Zhang *, Nina He, Yingxue Kou

School of Management, Qufu Normal University, Rizhao, China

* Corresponding Author Email: 18862087376@163.com

Abstract. To further investigate the impact of the COVID-19 pandemic on the operational efficiency of hospitals in China, this article uses the DEA-Malmquist model to measure and analyze the operational efficiency of hospitals in 31 provinces across the country from 2015 to 2021. The research results indicate that environmental factors have reduced the operational efficiency of hospitals to some extent. In terms of the regional characteristics of efficiency, the mean total factor productivity in the southern regions is higher than that in the northern regions, but the average annual growth rates of comprehensive technical efficiency, pure technical efficiency, and scale efficiency in the northern regions are higher than those in the southern regions. In addition, the COVID-19 pandemic has had a significant impact on the operational efficiency of hospitals. The total factor productivity of hospitals in 2020 decreased by 19.6% compared to the previous year, and the comprehensive technical efficiency of hospitals in the northern regions decreased by 2.3% during the same period, while the southern regions showed an increase of 0.6%. The northern regions are more vulnerable to the impact of the pandemic.

Keywords: Three-stage DEA model Malmquist model, Operational efficiency of medical institutions.

1. Introduction

With the in-depth development of the supply-side structural health service reform, medical institutions at all levels are constantly exploring models and paths for high-quality development. The "Opinions on Further Improving the Medical and Health Service System" proposes that gradually improving the balance of resource allocation and services should be paid attention to, among them, the operating efficiency of medical institutions is an important index to evaluate the operation and management capabilities and service supply levels of medical institutions. However, public health emergencies such as major infectious diseases continue to impact the existing public health system. Expansion turned to quality and efficiency improvement. Therefore, this paper uses the three-stage DEA model to analyze the operational efficiency of medical institutions across the country, to provide suggestions for implementing efficient medical services, supplying high-quality medical resources, and promoting balanced regional distribution.

2. Review of relevant research literature

From the national anti-epidemic to the normalization of epidemic prevention and control, the efficient development of medical operation institutions has attracted much attention. Promoting the efficient allocation of high-quality medical resources and a balanced regional layout is an important measure to further improve the medical and health service system. At present, in view of the operation efficiency of medical institutions, China mainly conducts research and analysis from the two main structures of regional medical development level and medical structure efficiency evaluation.

2.1. Regional medical development level

Yan Xiaochang (2018) used the DEA-Tobit method to study the impact of government investment on the operating efficiency of medical and health institutions in various parts of China. The results showed that there was a serious imbalance in the operating efficiency of medical and health institutions in various regions of China.[1] To formulate differentiated policies in a targeted manner to promote the coordinated development of national medical care; **Han Yue (2018)** used the method of sum of squared dispersions in systematic clustering to illustrate the significant typical correlation between the economic conditions of various provinces and cities and the development of medical and health care;[2] **Tian Haoguo et al. (2023)** analyzed the operating efficiency of medical institutions in Jiangsu, Zhejiang, Shanghai, and Anhui, and proposed that the government should accelerate the construction of a medical service cooperation and sharing platform, and reduce the size of regional medical services.[3] Institutional operating efficiency differences.

2.2. Efficiency Evaluation of medical institutions

Wang Na (2022) used the CCR model of the data envelopment analysis method to analyze the operating efficiency of the service system of grass-roots medical institutions and proposed to focus on grass-roots medical institutions, starting from medical resources, medical treatment flow and social environmental factors, and combining the influence of spatial characteristics, so as to improve the efficiency of medical services; [4] **Chen Xinlan (2021)** used the super- efficient SBM - DEA The model analyzes the operating efficiency of public and private medical institutions and proposes that medical institutions should use technological progress to boost efficiency.[5]

The model adopted in the above literature cannot eliminate the interference of external environmental factors and random disturbance items, and it is difficult to obtain the efficiency value that reflects the operation of medical institutions across the country. The three-stage DEA model can overcome the defect on this issue. Therefore, this paper selects the medical structure of 31 provinces across the country as the target population, collects relevant data from 2016 to 2022, uses the three-stage DEA method for research and analysis, and then evaluates its operational efficiency.

3. Construction of the operating efficiency model of medical institutions

3.1. Research model

3.1.1. DEA——SFA model

This paper studies the three-stage DEA model proposed by Fried (1999, 2002) that introduces environmental factors and random noise. Disadvantages of the DEA model. For the research on the operating efficiency of medical institutions, the three-stage DEA model is used to remove the influence of environmental factors and random noise, and retain management inefficiencies, so that the operating efficiency of institutions can be evaluated more accurately.

(1) The first stage: The traditional DEA model analyzes the initial efficiency. The model is essentially a linear programming problem. In this paper, the input-oriented BCC (variable returns to scale) model is selected as follows:

$$min\,\theta - \varepsilon(\hat{e}^T S^- + e^T S^+) \tag{1}$$

$$s.t.\begin{cases} \sum_{j=1}^{n} X_j\lambda_j + S^- = \theta X_0 \\ \sum_{j=1}^{n} Y_j\lambda_j - S^+ = Y_0 \\ \lambda_j \geq 0, S^-, S^+ \geq 0 \end{cases} \tag{2}$$

In the formula, j=1, $2, \dots, n$represents the decision-making unit, X, Yrespectively, the input and output vectors, $\lambda_j$represents the weight coefficient, θrepresents the effective value of efficiency, $S^+$and S^-represents the slack variable.

(2) The second stage: The SFA-like stochastic frontier model eliminates environmental factors and random noise. The main task of this stage is to separate the three influences of management inefficiency, environmental factors, and random noise, and the SFA regression model was used to remove the influence of the latter two factors on the efficiency measure, and the input variables were adjusted.[6] The SFA-like regression function of the input-oriented class is constructed as follows:

$$S_{ni} = f(Z_i;\beta_n) + \nu_{ni} + \mu_{ni}; i = 1,2,\cdots,I; n = 1,2,\cdots,N \quad (3)$$

In the formula, S_{ni}represents $i$the slack value of Z_i the input of the decision-making unit; n represents the environmental variable, $\beta_n$which is the coefficient of the environmental variable; $\nu_{ni} + \mu_{ni}$ is the mixed error term, which ν_{ni} represents random noise and μ_{ni} represents management inefficiency. The adjustment formula is as follows:

$$X_{ni}^A = X_{ni} + [max(f(Z_i;\hat{\beta}_n)) - f(Z_i;\hat{\beta}_n)] + [max(\nu_{ni}) - \nu_{ni}] \\ i = 1,2,\cdots,I; n = 1,2,\cdots,N \quad (4)$$

In the formula, X_{ni}^Arepresents the input after adjustment; X_{ni}represents the out before adjustment; $[max(f(Z_i;\hat{\beta}_n)) - f(Z_i;\hat{\beta}_n)]$represents the adjustment of environmental factors; $[max(\nu_{ni}) - \nu_{ni}]$presents the adjustment of random noise.

3.1.2. Malmquist exponential model

In the third stage, the Malmquist model is used to substitute the adjusted input and output indicators to calculate the dynamic efficiency of each decision-making unit in different periods.The traditional model cannot compare the changes in efficiency at different times because the frontiers in different periods are different, but the Malmquist exponential model can overcome this shortcoming and compare multiple periods. Its function is as follows:

$$M(x^{t+1}, y^{t+1}, x^t, y^t) = EC \times THC = \frac{D_v^{t+1}(x^{t+1},y^{t+1})}{D_v^{t+1}(x^t,y^t)} \times \left[\frac{D_v^t(x^{t+1},y^{t+1})}{D_v^{t+1}(x^{t+1},y^{t+1})} \times \frac{D_v^t(x^t,y^t)}{D_v^{t+1}(x^t,y^t)}\right]^{\frac{1}{2}} \quad (5)$$

In the formula, EC indicates a change in efficiency, and TEC represents the change in technical efficiency.

3.2. Variable selection

3.2.1. Efficiency evaluation index variables

Accurate evaluation of decision-making units requires the selection of appropriate input and output indicators.

Yan Xiaochang (2018) divides the investment of medical institutions into capital investment and personnel investment. In this paper, the total number of medical personnel is selected in terms of personnel investment, and the number of medical institutions and the number of beds in terms of capital investment are selected.

The production of the health care organization is measured by indicators such as the patient's nursing rate and the health status after the patient's recovery. Based on existing research, this paper selects three indicators as output variables: the number of outpatient consultations, the number of hospitalizations, and the utilization rate of hospital beds.[7] The bed utilization rate can better reflect the utilization of beds in medical institutions.

3.2.2. Environment variables

Operational efficiency of a medical institution refers to the ability of a medical institution to generate economic benefits using the assets under its control, that is, the equilibrium of input levels and service output. The operational efficiency in this paper refers to the comprehensive technical efficiency in the DEA model and measures the multi-faceted capabilities of the decision-making unit, such as resource allocation ability and resource use efficiency, which can be further decomposed into pure technical efficiency and scale efficiency. Among them, pure technical efficiency is related to management, technology, and other factors, and is positively correlated with management level; Efficiency at scale is closely related to production scale.

Xia Fang et al. (2018) pointed out that with the current unbalanced economic development in various regions, the economic level will significantly affect the service level of medical institutions.[8] Therefore, this paper selects regional GDP as the environmental factor. Medical institutions mainly serve people. The number of permanent residents further affect the operating efficiency of medical institutions through the number of services and resource allocation that affect medical institutions. Therefore, based on existing research and data availability, this paper selects regional GPD, resident population, proportion of urban population, and basic medical insurance coverage as environmental factors.

3.3. Data Source and Processing

This paper takes the medical institutions in 31 provinces of the country as the target population, selects the number of beds in medical institutions, the total number of medical institutions and the total number of medical staff as input variables, and the number of outpatient visits, number of hospitalizations and hospital bed utilization rate as output variables. The data come from the 2016-2022 "China Health Statistical Yearbook" and "China Health and Family Planning Statistical Yearbook". The number of the resident population, basic medical insurance coverage, GDP, and the proportion of urban population come from the 2016-2022 "China Statistical Yearbook" and "China Demographic Yearbook".

4. Analysis of the Empirical Results of Operational Efficiency of Medical Institutions

4.1. The first stage: Analysis of the initial operational efficiency of the traditional DEA model

In the first stage of the article, the operating efficiency of medical institutions in 31 provinces across the country was measured from 2015 to 2021. The sample data were analyzed for efficiency based on the variable return to scale model application software DEAP2.1. Give the results as follows.

Table 1. Comprehensive technical efficiency of each province from 2015 to 2021.

	2015	2016	2017	2018	2019	2020	2021	average
Beijing	0.936	0.988	0.945	0.979	1.000	0.922	1.000	0.967
Tianjin	0.991	0.993	0.978	1.000	1.000	1.000	1.000	0.995
Hebei	0.873	0.913	0.876	0.856	0.818	0.807	0.712	0.836
Shanxi	0.584	0.621	0.644	0.676	0.635	0.620	0.622	0.629
Inner Mongolia	0.637	0.672	0.690	0.704	0.649	0.620	0.620	0.656
liaoning	0.744	0.754	0.755	0.742	0.715	0.668	0.686	0.723
Jilin	0.692	0.712	0.727	0.710	0.697	0.591	0.649	0.683
Heilongjiang	0.759	0.800	0.798	0.790	0.790	0.537	0.627	0.729
Shanghai	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Jiangsu	0.967	0.957	0.956	0.923	0.899	0.910	0.873	0.926
zhejiang	0.983	0.999	1.000	1.000	1.000	1.000	0.977	0.994
Anhui	0.990	1.000	1.000	0.999	0.943	0.982	0.845	0.966
Fujian	0.880	0.893	0.889	0.884	0.874	0.888	0.799	0.872
Jiangxi	1.000	1.000	1.000	1.000	0.999	1.000	0.945	0.992
Shandong	0.837	0.887	0.891	0.870	0.847	0.865	0.831	0.861
Henan	0.880	0.895	0.906	0.925	0.932	0.951	0.861	0.907
Hubei	0.979	1.000	1.000	1.000	1.000	0.895	0.939	0.973
Hunan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Guangdong	1.000	1.000	1.000	1.000	0.999	0.952	0.951	0.986
Guangxi	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Hainan	0.944	0.938	0.974	0.956	0.871	0.889	0.815	0.912
Chongqing	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Sichuan	0.965	0.980	0.994	0.968	0.989	0.997	0.928	0.974
Guizhou	0.951	0.929	0.921	0.984	0.965	0.951	0.933	0.948
Yunnan	1.000	1.000	0.975	1.000	0.963	1.000	0.991	0.990
Tibet	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Shaanxi	0.787	0.808	0.844	0.870	0.823	0.754	0.789	0.811
Gansu	0.862	0.921	0.919	0.948	0.906	0.882	0.810	0.893
Qinghai	0.958	0.978	0.936	0.965	0.986	1.000	1.000	0.975
Ningxia	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Xinjiang	0.995	0.999	0.967	0.950	0.986	0.834	0.834	0.938
average	0.910	0.924	0.922	0.926	0.912	0.888	0.872	0.908

The measurement of the traditional DEA model in the first stage, the comprehensive technical efficiency of medical institution operations mostly exceeded 0.9, while under the influence of the epidemic in 2020, the operational efficiency of medical institutions in all provinces decreased. In Table 1, the comprehensive technical efficiency of Shanghai, Hunan, Guangxi, Chongqing, Tibet, and Ningxia is 1, indicating that the resource allocation efficiency and management technology in these regions have reached the optimal, while the comprehensive technical efficiency of Shanxi, Inner Mongolia, and Jilin is low, and the resource allocation and management technology needs to be improved. According to the Qinling-Huaihe River line, China is divided into south and north, and the operational efficiency of medical institutions in the south is generally higher than that in the north.[9]

4.2. The second stage: SFA-like regression model to eliminate environmental factors and random noise results analysis

Taking the input relaxation variable obtained above as the explanatory variable and the environmental factor as the explanatory factor, the Frontier4.1 software was used to resemble SFA regression analysis on the data from 2015 to 2021 one by one, and the results are shown in Table 2(due to space reasons, this paper chooses the regression analysis results of 2015 to present).

Table 2. Summary of SFA model regression results.

	Slack in the number of beds in medical institutions	Slack in the total number of medical institutions	Slack in the total number of medical staff
Intercept term	-12841.231 *** (-12841.231)	-33855.086 *** (-33855.086)	-93851.699 *** (-93851.704)
Permanent population	1.2537706 (1.963)	3.0299406 *** (198.546)	9.672643 *** (5.361)
Medicare coverage	-14305.077 *** (-14305.077)	-34234.361 *** (-34234.361)	-59826.587 *** (-59826.587)
GDP	-0.13299053 (-1.040)	-0.45856464 *** (-103.209)	-2.2031118 *** (-12.911)
Proportion of the urban population	229.15062 *** (229.164)	698.70626 *** (698.558)	1889.2238 *** (1888.029)
sigma-squared	169943310 *** (169943310.00)	1135317900 *** (1135317900)	2919790800 *** (2919790800)
sigma-squared	0.99998003 *** (1591.611)	0.99999998 *** (82643818)	0.99999999 *** (417454.010)
log-likelihood	-313.84266	-342.90764	-364.16496
LR	18.990727	19.736062	6.9993829

Note: The results in brackets represent the t-test of the coefficients, ***, **, * represent the significance levels at 1%, 5%, and 10%, respectively.

Table 2 shows that the relaxation γ values of the three regression models are all close to 1, and pass the significance test at the 1% level, so the SFA-like estimation results are believed to be credible.

When the regression coefficient is negative, the relationship between environmental variables and input slack variables is negative, and the increase of environmental variables is conducive to reducing input slack variables, and vice versa. This enables the analysis of environment variables:

(1) The number of permanent residents. The number of permanent residents is positively correlated with the three input variables. As the number of permanent residents increases, it will stimulate changes in the number of medical institutions and personnel, increase management inefficiency, and affect the operating efficiency of medical institutions.

(2) GDP. Gross regional product and the three input variables are all negatively correlated, so the increase in GDP harms the reduction of the redundancy of the input variables. On the one hand, an increase in GDP per capita stimulates an increase in operational efficiency. On the other hand, the increase in regional GDP is conducive to medical institutions making full use of their resources and improving management efficiency.

(3) Medicare coverage. There is a significant negative effect between the coverage of medical insurance and the three inputs. Under the influence of the government, more and more residents purchase medical insurance, more residents are effectively guaranteed, and the operating efficiency of medical institutions has also been improved.

(4) Proportion of urban population. The proportion of the urban population correlates significantly positively with the number of medical facilities and the total number of medical personnel. An increase in the proportion of the urban population may bring certain difficulties to institutional management and lead to increased management inefficiency. The increase is extensive.

Therefore, the operational efficiency is affected by different degrees and directions of environmental factors, and the original input value has to be adjusted to eliminate the influence of external environmental factors.

4.3. The third stage: DEA-Malmquist efficiency analysis adjusted for input-output variables

The Malmquist index model can compare the data of different periods of different stochastic frontiers. This article analyze the adjusted data of the second stage from 2015 to 2021 and compares the southern and northern parts of the country with the Maquist modle. The input and output variables are analyzed using Deap2.1 software and the results are as follows.

Table 3. Malmquist Index of Medical Institutions and Its Decomposition Index.

years	EFFCH _	T ECHCH	P ECH	S ECH	M index
2015-2016	1.021	1.005	1.013	1.008	1.026
2016-2017	0.994	0.985	0.995	0.999	0.98
2017-2018	0.992	0.998	0.993	0.999	0.99
2018-2019	0.98	0.958	0.986	0.994	0.938
2019-2020	0.978	0.822	0.981	0.997	0.804
2020-2021	1.01	0.907	1.009	1.001	0.916
mean	0.996	0.944	0.996	1	0.939

Table 4. Malmquist Index and Its Decomposition Index of Southern Medical Organizations.

years	EFFCH	TECHCH	PECH	SECH	M index
2015-2016	0.999	1.01	1.001	0.998	1.009
2016-2017	1	0.992	0.995	1.005	0.992
2017-2018	0.977	0.962	0.994	0.983	0.94
2018-2019	1.021	1.055	1.009	1.012	1.077
2019-2020	1.006	0.979	1	1.005	0.985
2020-2021	0.991	1.002	0.995	0.996	0.993
mean	0.999	1	0.999	1	0.998

Table 5. Malmquist Index and Its Decomposition Index of Northern Medical Institutions.

years	EFFCH	TECHCH	PECH	SECH	M index
2015-2016	1.025	1.033	1.016	1.009	1.059
2016-2017	0.981	0.978	0.991	0.99	0.96
2017-2018	1.02	0.963	1.018	1.003	0.983
2018-2019	0.987	0.954	0.988	0.999	0.941
2019-2020	0.977	0.799	0.984	0.993	0.78
2020-2021	1.02	0.866	1.008	1.012	0.883
mean	1.001	0.929	1	1.001	0.93

4.3.1. The development trend of medical institutions in the North and South

As shown in Table 3, from 2015 to 2021, the total factor productivity index of medical institutions is 0.939, which means that the total factor productivity will decrease by 6.1% annually.[10] In terms of decomposition indicators, the comprehensive technical efficiency has an average annual decrease of 0.4%, its decomposition index pure technical efficiency has an average annual decrease of 0.4%, and the scale efficiency has an average annual decrease of 0.01%. It shows that the management level, technical level, and scale level of medical institutions have all declined, resulting in a decline in their operational efficiency. The average annual reduction in the efficiency of social technological progress is 5.7%, which play a role in the decline in the operating efficiency of medical institutions, indicating that medical institutions need to improve their grasp of new technologies and equipment. The development trend of total factor productivity in the north and south is shown in Figure 1 below.

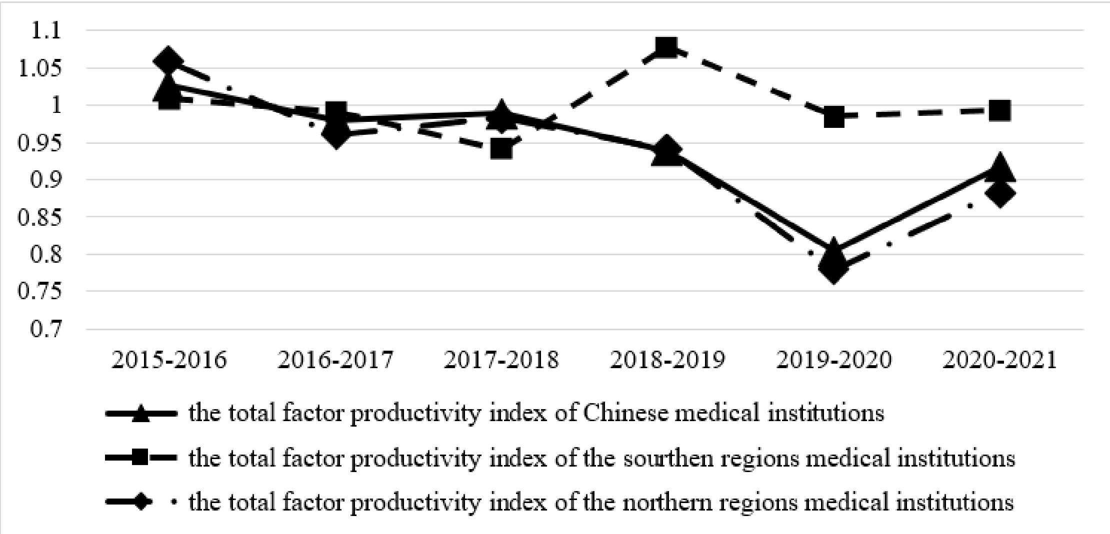

Figure 1. Total Factor Productivity of Medical Institutions.

As shown in Figure 1, in terms of regions, the M values of medical institutions in the south are mostly higher than those in the north. The shifting trend of the total factor productivity index of the northern regions and domestic medical institutions is the same. The northern regions especially need to make reasonable use of environmental variables to improve comprehensive technical efficiency. The comprehensive technical efficiency of medical institutions in the south decreases by 0.1% annually, while that in the north increases by 0.1% annually, which shows that the management level, technical level, and scale level of medical institutions in northern have improved, and the south needs to increase resources allocation and technical level. Attention. The social and technological progress efficiency in the north has decreased by an average of 7.1% per year, which shows that medical institutions in the north are seriously lacking in mastering new technologies and new equipment. In the future, they need to invest a lot of energy in the development of new technologies, new products, and new equipment.

4.3.2. The impact of the epidemic on the operating efficiency of medical institutions

Table 3 shows that the total factor productivity index of medical institutions from 2019 to 2020 is 0.804, that is, the total factor productivity will decrease by 19.6% annually. The operating efficiency of medical institutions has been greatly affected by the impact of the epidemic. From the perspective of decomposition indicators, the comprehensive technical efficiency in 2020 has dropped by 2.2% compared with 2019, which shows that in the case of the epidemic, external environmental factors such as regional GDP and resident population will affect the management level of medical institutions. Efficiency drops. Medical institutions must formulate emergency measures in advance to deal with the decline in management level caused by public emergencies. In addition, the efficiency of social and technological progress declined by 17.8%, and the total factor productivity of medical institutions declined mainly because of the decline of social and technological progress. The epidemic has had a huge impact on the innovation and progress of medical technology.

From Tables 4 and 5, it can be seen that the comprehensive technical efficiency in the northern region decreased by 2.3%, while that in the southern region increased by 0.6%, indicating that in the face of the epidemic and the increase in patients, medical institutions in the southern region can quickly adjust resource allocation and strengthen management, while the northern region needs to further deepen the Awareness of measures to be taken in public health events to meet social needs for medical treatment. Its decomposition indicators, pure technical efficiency and scale efficiency, both decreased in the northern region, showing that the epidemic had an impact on the technological innovation and scale of northern medical institutions. However, the south is opposite to the north. In the face of public health emergencies, medical institutions in the southern region have improved their management, rationally allocated resources, and expanded their scale.

The new crown epidemic has had a major impact on the operating efficiency of medical institutions in China. After the epidemic, medical industry is recovering. The comprehensive technical efficiency in 2021 will increase by 0.1% compared with 2020. With the advancement of social technology, China’s medical industry will tend to develop well.

5. Conclusions and Suggestions

This paper uses the DEA-Malmquist index analysis model to study the impact of the epidemic on the operating efficiency of medical institutions, conducts a dynamic analysis of the operating efficiency of medical institutions in the north and south from 2015 to 2021, and draws the following conclusions:

5.1. Strengthen the construction of medical infrastructure and scientifically allocate medical resources

The number of outpatient visits, number of hospitalizations, and hospital bed utilization in medical institutions are all affected by infrastructure. Therefore, it is necessary to scientifically allocate resources in medical institutions in light of local medical needs. Effectively adjust the investment of medical resources to avoid resource redundancy caused by excessive addition of personnel positions and medical institutions. At the same time, the increase in regional GDP and basic medical insurance coverage has a positive effect on medical institutions. By improving medical insurance coverage, rationally arranging input resources, choosing a reasonable input plan, and optimizing input and output, it can promote the rationalization of medical institution resources. Configuration, and effectively improve operational efficiency. In addition, given the low technical efficiency in the northern region, investment in medical technology and medical education resources should be increased, while the management factors in the southern region are slightly inferior. Policy guarantees, system reforms, and rational allocation of medical resources in different regions should be strengthened.

5.2. Improve the construction of the health incident response mechanism and promote regional joint prevention and control

From 2019 to 2020, the total factor productivity of medical institutions will decrease by 19.6% annually. The new crown epidemic will have a huge impact on medical institutions. The comprehensive technical efficiency of the northern institutions will drop by 2.3%. After the epidemic, the comprehensive technical efficiency of medical institutions will increase by 0.1%. The comprehensive technical efficiency, pure technical efficiency, and scale efficiency in the northern region have increased, but the efficiency of social technological progress has decreased, while the opposite is true in the southern region. It shows that China’s medical institutions still lack a robust and perfect response mechanism, so it is significant to streamline the approval process and develop the ability of medical institutions to respond to public health emergencies. Simultaneously strengthening actual time sharing of regional information, promote the development of regional joint prevention and control, realize the joint coordination of multiple regions and departments when an incident occurs, mobilize medical resources as soon as possible, help medical institutions to carry out their work in an orderly manner, and alleviate the huge impact of the incident.

5.3. Promote the construction of regional medical centers and strengthen regional exchanges and mutual learning

After removing environmental factors and random noise, it can be found that the total factor production index of medical institutions in China decreases annually, the comprehensive technical efficiency of medical institutions in the south decreases by 0.1% per year, and the average annual increase in the north increases by 0.1%. Low socio-technical efficiency leads to a low total factor index in the north, while low comprehensive technological efficiency leads to a low total factor index in the south. Therefore, given the uneven development of the operational efficiency of institutions among regions, it is significant to strengthen the construction of regional medical centers, expand the capacity of high-quality medical resources, narrow the regional gap at the medical level, share public health tasks at multiple places, and jointly solve the problems of medical development. At the same time, it promotes the exchange and learning of medical institutions in the North and the South. The development status of the medical institutions in the north and the south shows a complementary trend. The level of technological innovation in the South is relatively high, and the North has significant advantages in terms of management level and scale efficiency. Medical institutions in the north and south should establish a mutual exchange and learning mechanism so that medical institutions in China can fully and efficiently master new technologies and equipment, and reduce management inefficiency. In addition, strengthen learning cooperation between China and the international field, and realize open cooperation and mutual benefit sharing in the medical field.

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