

Study on Health Resource Allocation Efficiency of Medical Institutions in Xinjiang under the Background of Hierarchical Diagnosis and Treatment

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Abstract

Objective: To analyze the allocation of health resources in medical institutions in Xinjiang from 2013 to 2022, and to provide some reference for further optimizing the allocation of health resources. **Methods:** DEA-Malmquist index model and DEA-BCC model were used to analyze the current situation of health resource allocation efficiency of medical institutions in Xinjiang based on dynamic and static perspectives. **Results:** The average total factor productivity of medical institutions in Xinjiang from 2013 to 2022 was 0.913. In 2022, the average comprehensive benefit between health resources and medical institutions in Xinjiang is 0.775, half of the medical institutions are in non-DEA effective state, and the allocation efficiency of health resources needs to be further improved. **Conclusion:** Due to the adjustment of policy planning and the impact of the epidemic, the production efficiency of medical institutions in Xinjiang has declined. It is necessary to comprehensively analyze the factors affecting the efficiency of health resource allocation, and further improve the efficiency of health resource allocation in Xinjiang by means of technological innovation and health resource investment planning.

Keywords

Health Resources; Hospital Management; DEA; Efficiency Evaluation.

1. Introduction

The allocation of health resources is an important starting point to promote the equity of national health and improve the accessibility of public health services. With the continuous emergence of new medical technologies and the acceleration of the aging process of the population, health costs continue to rise [1], and there is a gap in the allocation of health efficiency between different regions [2] and between urban and rural areas [3]. Improving efficiency has gradually become an important goal for the high-quality development of health systems and an important issue in national health policy discussions. In 2015, The State Council issued the Outline of the National Medical and Health Service System Plan (2015-2020) and the Guiding Opinions on Promoting the Construction of a Hierarchical Diagnosis and Treatment System. The former requires scientific division of the scale and distribution of medical and health resources, and formulation of guiding allocation standards to guide resources to the weak areas and fields; The latter emphasizes on promoting the sinking of high-quality medical resources, improving the efficiency of resource utilization and the overall benefit. Hierarchical diagnosis and treatment system has become the key to rational allocation of medical resources and optimization of allocation efficiency. Based on this background, Malmquist index and DEA-BCC model were used to analyze the change and current situation of health resource allocation efficiency in Xinjiang, providing some reference suggestions for reducing medical cost and optimizing medical service supply.

2. Data and Methods

2.1. Data Sources

The data related to medical and health care in Xinjiang were obtained from the Statistical Yearbook of Xinjiang from 2013 to 2022. The data indicators include the number of health institutions, the number of beds, the number of health technicians, the number of outpatient visits and the number of discharged patients.

2.2. Research Methods

Data Envelopment Analysis (DEA) is a systematic analysis method to study the effective relative efficiency between multiple input and multiple output decision units [4]. The DEA-Malmquist index model mainly reflects the change of DMU productivity in different periods, which is mainly reflected by total factor productivity. Dea-bcc model is one of the data envelopment analysis (DEA) methods, which is mainly used to measure the pure technical efficiency and scale efficiency of DMU under the condition of variable returns to scale.

2.3. Index Selection and Decision Making Unit Design

Based on relevant research fields and data availability, three input indicators were selected for the study, including the number of institutions, the number of health technicians and the number of beds. The output indicators were selected for the number of outpatient visits and the number of discharged patients. Combined with the data published in Xinjiang in the past ten years, 12 types of medical institutions under four kinds of medical institutions were selected as the decision units required by the EA model. It should be noted that the classification of medical institutions in the study was based on the classification standards of medical and health institutions in the China Health Statistical Yearbook.

3. Result Analysis

3.1. Dynamic Analysis of Health Resource Allocation Efficiency of Medical Institutions in Xinjiang

Table 1. Malmquist index of health resource allocation in medical and health institutions in Xinjiang during 2013-2022

Time dimension change trend and its decomposition					
A given year	Technical efficiency(EC)	Technological progress(TC)	Pure technical efficiency(PEC)	Scale efficiency(SEC)	Total factor productivity(TFP)
2013-2014	0.936	1.148	0.949	0.987	1.075
2014-2015	1.224	0.918	1.041	1.176	1.124
2015-2016	1.018	1.016	1.009	1.010	1.035
2016-2017	0.994	0.977	0.974	1.020	0.972
2017-2018	0.970	1.019	1.001	0.969	0.988
2018-2019	0.912	0.961	1.054	0.865	0.876
2019-2020	0.999	0.978	0.991	1.009	0.977
2020-2021	0.920	0.786	0.979	0.939	0.723
2021-2022	0.881	0.674	0.939	0.938	0.594
Mean value	0.980	0.932	0.992	0.987	0.913

The analysis results of time-dimensional health resource allocation efficiency of medical institutions in Xinjiang during 2013-2022 are shown in Table 1. Among them, the total factor productivity of all medical institutions from 2013 to 2016 was greater than 1, indicating that the total factor productivity of medical institutions was on the rise during the three years. From 2016 to 2022, the total factor productivity of medical institutions in Xinjiang was all less than 1, indicating that the operating efficiency of medical institutions was in a state of small lazy decline on the whole during the six years. From 2020 to 2022, the total factor productivity of medical institutions in Xinjiang has declined significantly. The index decomposition shows that both the technical efficiency index and the technological progress index are less than 1 in these two years, and the technological progress index has decreased by 21.4% and 32.6% respectively, which is far less than the average annual technological progress index, resulting in the decline of the total factor productivity of the overall medical institutions. This indicates that all medical institutions have experienced a significant technological regression in the past two years.

Table 2. Spatial dimension change trend of Malmquist index of health resources in medical and health institutions in Xinjiang
Its index breakdown (2013-2022)

Organization name	Technical efficiency(EC)	Technological progress(TC)	Pure technical efficiency(PEC)	Scale efficiency(SEC)	Total factor productivity(TFP)
General hospital	1.000	0.996	1.000	1.000	0.996
Hospital of Chinese medicine	1.000	0.984	1.000	1.000	0.984
Hospital of Integrated Chinese and Western Medicine	1.001	0.954	0.978	1.024	0.955
National hospital	0.988	0.970	0.988	1.000	0.959
Specialized hospital	1.027	0.970	1.026	1.000	0.996
Community health service center (station)	1.000	0.969	1.000	1.000	0.969
Health center	1.000	0.954	1.000	1.000	0.954
Out-patient department	0.927	0.924	0.919	1.008	0.856
Clinic. Health clinic. Infirmary	1.000	0.620	1.000	1.000	0.620
Specialized disease prevention and control center	0.975	0.980	1.000	0.975	0.956
Maternal and child Health care center	1.000	0.977	1.000	1.000	0.977
Nursing homes/rehabilitation medical facilities	0.851	0.962	1.000	0.851	0.818
Mean value	0.98	0.932	0.992	0.987	0.913

The allocation of health resources among medical institutions in Xinjiang during 2013-2022 was compared from spatial dimension, and the results were shown in Table 2. The results show that the efficiency of resource operation in the past 10 years is the highest in general hospitals and specialized hospitals, followed by traditional Chinese medicine hospitals, and the lowest in clinics/health offices/infirmary. By decomposing the total factor productivity index, it is found that the technical efficiency index of integrated Chinese and Western medicine hospitals and specialized hospitals is greater than 1, indicating that the speed of technological progress is relatively effective. The health technology efficiency index of five institutions, general hospital,

traditional Chinese medicine hospital, community health service center (station), health center, clinic/health office/infirmarary and maternal and child health hospital (station), is equal to 1, indicating that their technological progress rate is relatively effective. The technical efficiency index of ethnic hospitals, outpatient departments, specialized disease prevention and control hospitals (stations) and sanatoriums/rehabilitation medical institutions is less than 1, and the sanatoriums/rehabilitation hospitals have the lowest technical efficiency index. By analyzing the technical progress index of medical institutions, it is found that the technical progress index of all institutions is less than 1, and the general hospital has the highest technical progress index, followed by the hospital of traditional Chinese medicine. The lowest technical progress index was found in clinics/health offices/dispensaries, with an index of 0.62 well below the average. On the whole, the total factor productivity among the 12 types of medical institutions in Xinjiang in the past ten years was less than 1, with an average value of 0.913, and the total factor productivity of medical institutions decreased by 8.7% on average annually. There is still room for improvement in the operational efficiency of medical institutions in Xinjiang.

3.2. Static Analysis of Health Resource Allocation Efficiency of Medical Institutions in Xinjiang

Table 3. Static efficiency of health resource allocation in Xinjiang hospitals in 2022

Institution	Comprehensive benefitOE(θ)	Technical benefitTE	Economies of scaleSE(k)	Returns to scale	Effectiveness
General hospital	1	1	1	-	DEA strong and efficient
Hospital of Chinese medicine	1	1	1	-	DEA strong and efficient
Hospital of Integrated Chinese and Western Medicine	0.663	0.818	0.811	irs	Non-dea effective
National hospital	0.881	0.884	0.997	irs	Non-dea effective
Specialized hospital	0.722	0.722	1	irs	Non-dea effective
Community health service center (station)	1	1	1	-	DEA strong and efficient
Health center	1	1	1	-	DEA strong and efficient
Out-patient department	0.451	0.456	0.99	irs	Non-dea effective
Clinic. Health clinic. Infirmary	1	1	1	-	DEA strong and efficient
Specialized disease prevention and control center	0.536	1	0.536	irs	Non-dea effective
Maternal and child Health care center	1	1	1	-	DEA strong and efficient
Nursing homes/rehabilitation medical facilities	0.045	1	0.045	irs	Non-dea effective
Mean value	0.775	0.907	0.865	-	-

The allocation efficiency of health resources in medical institutions in Xinjiang in 2022 is shown in Table 3. The comprehensive technical efficiency and pure technical efficiency of 6 medical

institutions, including general hospital, traditional Chinese medicine hospital, community health service center (station), health center, clinic (clinic, medical office) maternal and child health hospital (station), are 1, and are in a strong and effective state of DEA, indicating that these 6 medical institutions have achieved the optimal allocation and utilization of health resources in this year, and are in the optimal state of efficiency. However, there are 6 non-effective medical institutions in DEA, accounting for 50% of the total, and these units are integrated hospitals of traditional Chinese and Western medicine, ethnic hospitals, specialized hospitals, outpatient departments, specialized disease prevention and control hospitals (stations) and sanatoriums/rehabilitation medical institutions, indicating that these institutions still have unreasonable resource allocation.

3.3. Input Redundancy Analysis of DEA Ineffective Agencies

The input redundancy analysis of non-DEA effective medical institutions can scientifically guide medical institutions to plan various input indicators from the perspective of supply, so as to improve their operational efficiency. In terms of the number of institutions, all medical institutions have the input redundancy of health institutions, and the redundancy rate of integrated Chinese and western medicine hospitals is the highest, followed by specialized disease prevention and control hospitals (stations). Among the bed number indicators, the number of beds in 4 medical institutions, including integrated traditional Chinese and Western medicine hospital, ethnic minority hospital, specialized hospital and sanatoriums/rehabilitation medical institutions, resulted in redundancy. Ethnic minority hospital had the highest redundancy rate and needed to reduce 2134 beds to achieve the optimal relative efficiency. Secondly, the hospital of integrated Chinese and Western medicine, based on the current output state, needs to reduce its bed input to 592 to achieve the optimal efficiency. Finally, in terms of health technical personnel, none of the 6 medical institutions produced redundancy, indicating that the health personnel allocation of these medical institutions was relatively scientific and reached the corresponding effective output level.

4. Discuss Suggestions

4.1. The Allocation Efficiency of Health Resources in Medical Institutions is Unstable, and the Efficiency Evaluation and Dynamic Adjustment Mode of Resources Should Be Improved

In 2017, the Xinjiang government issued the Notice on Printing and distributing the Plan of the Medical and Health Service System of the Autonomous Region (2016-2020), aiming at the scientific, rational and standardized layout of medical and health institutions and their resource allocation in Xinjiang. According to the research results, since 2016, the total factor productivity of medical institutions in Xinjiang has shown a downward trend, which further proves the guidance of planning and implementation on resource input, but also highlights that the limitation of resource input may restrict the efficiency of medical service when technical efficiency and medical technology level have not been effectively improved. It is worth noting that the total factor productivity of medical institutions fell sharply in 2022, and this change may be closely related to the decrease in hospital discharge due to the decline in hospital business volume in the context of the epidemic. Whether it is the adjustment of policy planning or the impact of the epidemic environment, the efficiency of medical service is affected by multiple complex factors to a certain extent. Therefore, when analyzing the causes of the decline in the efficiency of the medical service system, we must not only examine the internal operating factors of medical institutions, but also deeply understand the profound impact of the external environment on the efficiency of medical and health resource allocation. It is necessary to comprehensively consider internal and external factors, and actively explore innovative

efficiency evaluation methods to accurately identify existing problems and influencing factors in resource allocation. To evaluate and drive decision-making, optimize the emergency management ability of the medical service system, enhance its adaptability and resilience, so as to ensure the stable and efficient operation of the medical service system.

4.2. The Allocation Efficiency of Health Resources in Medical Institutions Needs to Be Further Improved, and Technological Innovation is the Breakthrough

The research results show that the average health resource allocation efficiency of medical and health institutions in Xinjiang from 2013 to 2022 is 0.913. Combined with the static analysis of the health resource allocation efficiency of medical institutions in 2022, it is found that there are 6 non-DEA effective institutions among the 12 medical institutions, accounting for half of the total number, indicating that the health resource allocation efficiency of medical institutions in Xinjiang needs to be further optimized. Through in-depth analysis of the comprehensive benefit index of medical institutions, it is found that the decline of technological innovation index is an important aspect affecting the resource allocation efficiency of medical institutions in Xinjiang. Promoting technological innovation and improving the speed of technological progress has become an effective way to improve the resource allocation efficiency of medical institutions in Xinjiang. Suggestion: Firstly, the operation efficiency of medical institutions should be improved by means of information technology. For example, population health informatization and information platform construction and networking of medical institutions at all levels; Secondly, innovate the medical service delivery model, promote the circulation of medical resources through platforms such as telemedicine, interregional medical community and community participation, and maximize the utilization of resources without increasing medical costs. Improve human skills, standardize medical personnel training mechanism based on demand, improve the introduction of senior personnel channels, strengthen the construction of grassroots medical and health personnel, and constantly improve the technical level of health personnel.

4.3. There is a Certain Degree of Redundancy in the Input of Health Resources, and the Fine Management of Health Resources Should Be Strengthened

The redundancy analysis of input resources in non-DEA effective medical institutions found that the six medical institutions with DEA ineffective had different degrees of input redundancy of health resources. Among them, 6 units had redundancy generation of health institutions, and 4 medical institutions had redundancy generation of number of beds, while no redundancy generation was invested in health technicians. Through the input relaxation analysis of non-DEA effective hospitals, it is suggested to first identify which institutions have resource redundancy, and then adjust different health resources, such as institutions, beds and manpower. The improvement of health resource allocation efficiency is not only about increasing input and expanding scale, but also about optimizing input structure and rationalizing system. It should be based on the level of local medical development and the needs of medical services, precise distribution, overall consideration, and constantly improve the operational efficiency of medical institutions. In the context of hierarchical diagnosis and treatment, do a good job of two-way referral, effectively use the resources of different levels of medical institutions, and improve the overall service efficiency of the medical system.

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