

The Current Status and Equity of Health Resource Allocation in Hebei Province from 2019 to 2021 - Based on the Gini Coefficient and Lorenz Curve

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Abstract

Purpose Analyze the main health resource allocation in various cities of Hebei Province from 2019 to 2021, analyze the fairness of its allocation, and provide reference for further optimizing the allocation of health resources in Hebei Province. **Method** Using the "Statistical Yearbook of Hebei Province" as the data source, selecting the number of medical and health institutions per thousand people, the number of actual medical and health institution beds per thousand people, and the number of health technicians per thousand people in Hebei Province as key measurement indicators, adopting the Gini coefficient to explore the fairness of the allocation of health resources in various cities of Hebei Province from the dimensions of total population and geographical area and analyze and evaluate the trend of its change. **Results** The main health resources in Hebei Province maintained stable growth from 2019 to 2021, with an average annual growth rate of 3.87% in the number of beds per thousand people; the Gini coefficient showed fluctuating changes but always remained below 0.3, indicating that the allocation of health resources in Hebei Province is in a fair state. **Conclusion** The total amount of health resources in Hebei Province is increasing year by year, and the allocation is fair, but there are still problems such as uneven distribution and unreasonable structure. The government should increase the investment in health resources, improve the fairness and accessibility of health resource allocation.

Keywords

Health resource allocation; Equity; Gini coefficient.

1. Introduction

Health resources encompass the sum of elements invested in various health services, and their rational allocation is crucial for the balanced and sustainable development of the healthcare sector[1] In recent years, both national and local governments have successively introduced policy documents to promote the coordinated development of health and well-being. The "Healthy China 2030" Outline[2] and the "14th Five-Year Plan" for the Construction of a High-quality and Efficient Medical and Health Service System[3] stipulate the optimization of the medical service system, improvement of the equity in health resource allocation, strengthening the construction of public medical and health institutions, and promoting the expansion of high-quality medical resources with a balanced regional distribution. To implement the national plan for the construction of the medical and health service system during the "14th Five-Year Plan" period, Hebei Province has introduced its own "14th Five-Year Plan" for the medical and health service system. The central government and the State Council attach great importance to the coordinated development of the Beijing-Tianjin-Hebei region. Hebei Province plays a crucial role in deepening the synergy of the Beijing-Tianjin-Hebei integration. However, the per capita hospital beds and the number of physicians per ten thousand population in Hebei Province are

the lowest among the three regions, not only having fewer resources but also weaker healthcare service quality compared to Beijing and Tianjin[4]. Therefore, the research on the current status of health resource allocation and its equity analysis in Hebei Province holds practical significance.

To further explore the health resource allocation in various regions of Hebei Province and enhance the equity of health resources, this paper selects the number of medical and health institutions, the number of beds in medical and health institutions, and the number of health technical personnel in Hebei Province from 2019 to 2021 as measurement indicators. The Gini coefficient is calculated based on population and geographical dimensions, and Lorenz curves are constructed to analyze the health resource allocation and equity in different regions of Hebei Province from 2019 to 2021.

2. Research Methodology

2.1. Data Source:

This article uses data from the "Statistical Yearbook of Hebei Province" to measure the allocation of medical and health resources in Hebei Province, including Shijiazhuang City (including Xinji City), Chengde City, Zhangjiakou City, Qinhuangdao City, Tangshan City, Langfang City, Baoding City (including Dingzhou City, Xiong'an New Area), Cangzhou City, Hengshui City, Xingtai City, and Handan City. The indicators used for measurement include the total population, geographical area, number of medical and health institutions, number of beds in medical and health institutions, and number of health technical personnel.

2.2. Research Method

The study uses Excel 2013 to calculate the total population, number of medical and health institutions, number of beds in medical and health institutions, and number of health technical personnel in various cities of Hebei Province. It calculates the Gini coefficient of health resource allocation in Hebei Province from the dimensions of population and geographical area, and analyzes the fairness of health resource allocation.

2.2.1. Gini Coefficient

The Gini coefficient is calculated based on the Lorenz curve and is used to measure the income gap among residents in various countries or regions, analyzing the fairness of income distribution in economics[5]. Currently, the healthcare sector adopts this indicator data and standards for health economic analysis[6].

The formula for calculating the Gini coefficient is $G = 1 + \sum_{i=1}^n Y_i P_i - 2 \sum_{i=1}^n (\sum_{j=1}^i P_j) Y_i$, where (G) represents the Gini coefficient, (P_i) represents the proportion of the population of each city in Hebei Province to the total population; (Y_i) refers to the proportion of the number of health resources owned by each city in Hebei Province to the total number of health resources; ($\sum P_j$) is the cumulative population proportion arranged from low to high according to population income. (P) corresponds to the two-dimensional indicators of population and area[9]. (G) ranges from 0 to 1. The Gini coefficient ranges between 0 and 1. The closer it is to 0, the more equitable the distribution of healthcare resources. A Gini coefficient of less than 0.3 indicates a relatively good level of equity, while a range of 0.3 to 0.4 suggests a reasonably fair distribution. A coefficient exceeding 0.4 reflects a significant level of inequality, and if it surpasses 0.6, it signifies a highly inequitable distribution.

2.2.2. The Lorenz curve

The Lorenz curve is commonly used in the field of healthcare to analyze and assess the fairness of the allocation of medical resources. This study involves calculating and ranking the quantity of healthcare resources per thousand people and per square kilometer in Hebei province for

the years 2019-2021. The X-axis corresponds to the cumulative percentage of population (or geographic area) in each city in Hebei province, while the Y-axis represents the cumulative percentage of various healthcare resources that each city possesses, relative to the total healthcare resources in Hebei province. The closer the Lorenz curve is to the line of absolute equality, resembling a 45-degree angle, the higher the degree of fairness.

3. Result

3.1. From 2019 to 2021, the basic situation of healthcare resource allocation in Hebei Province is as follows

Hebei Province is comprised of 11 prefecture-level cities, including 49 municipal districts, 21 county-level cities, 91 counties, and 6 autonomous counties. As of the end of 2021, the resident population of Hebei Province reached 74.48 million. The province had a total of 88,162 medical and healthcare institutions, representing a growth of 4.1% compared to 2019. The number of healthcare technical personnel amounted to 559,404, marking a growth of 14.1% since 2019. Additionally, the number of hospital beds in medical and healthcare institutions reached 454,830, showing an increase of 5.7% compared to 2019. Over recent years, Hebei Province has witnessed an increase in investment in healthcare resource allocation, with all indicators showing annual growth in 2019. (See Table 1 for details.)

Table 1 Basic situation of health resource allocation in Hebei Province from 2019 to 2021

Year	Population	Medical institutions	Hospital beds	Medical personnel
2019	75919700	84637	429926	490075
2020	74610235	86938	442932	520499
2021	74480000	88162	454830	559404
Average annual growth rate	-0.95%	2.06%	2.86%	6.84%

3.2. From 2019 to 2021, the allocation of healthcare resources per thousand people and per square kilometer in Hebei Province is as follows:

Indicators such as the number of hospital beds, medical institutions, and healthcare technical personnel per thousand people serve as metrics for evaluating healthcare resource allocation. In 2021, the national averages were 6.30 hospital beds, 0.73 medical institutions, and 9.97 healthcare technical personnel per thousand people.

In 2021, in Hebei Province, the number of hospital beds per thousand people was 6.11, reflecting a growth of 7.9% compared to the same period in 2019. The number of medical institutions per thousand people was 1.18, marking a 6.3% increase from 2019. Additionally, there were 7.51 healthcare technical personnel per thousand people, representing a growth of 16.2% compared to 2019.

Regarding the allocation of healthcare resources per square kilometer, in 2021, Hebei Province had 2.41 hospital beds, 0.47 medical institutions, and 2.96 healthcare technical personnel per square kilometer. These figures represent increases of 5.7%, 4.4%, and 13.8% respectively compared to 2019. Overall, from 2019 to 2021, there has been a consistent growth trend in the number of hospital beds, medical institutions, and healthcare technical personnel per thousand people, as well as per square kilometer in Hebei Province (see Table).

Table 2 Health resource allocation per thousand population and per square kilometer in Hebei Province, 2019-2021

Year	per 1000 population			per square kilometer		
	Medical institutions	Hospital beds	Medical personnel	Medical institutions	Hospital beds	Medical personnel
2019	1.11	5.66	6.46	0.45	2.28	2.60
2020	1.16	5.93	6.97	0.46	2.35	2.76
2021	1.18	6.11	7.51	0.47	2.41	2.96

3.3. From 2019 to 2021, the fairness of major healthcare resource allocation in Hebei Province is outlined as follows

3.3.1. Gini Coefficient

Following the calculation method for the Gini coefficient mentioned above, the indicators such as the number of hospital beds, medical institutions, and healthcare technical personnel per thousand people and per square kilometer were sorted from smallest to largest. The Gini coefficients for the allocation of these healthcare resources are presented in Table.

In 2021, the Gini coefficients for the allocation of medical and healthcare institutions, hospital beds, and healthcare technical personnel per thousand people were 0.090, 0.059, and 0.057, respectively. These coefficients, all below 0.1, indicate absolute fairness in resource allocation per population dimension. Notably, the allocation fairness is most pronounced in the case of healthcare technical personnel. In contrast, when considering the allocation per geographic area, the Gini coefficients were 0.0343, 0.344, and 0.372, all falling within the range of 0.3-0.4, indicating a normal state of fairness. Among these, the allocation fairness of medical and healthcare institutions was the highest.

Overall, the Gini coefficients suggest a high level of fairness in healthcare resource allocation per population dimension and a satisfactory level of fairness in allocation per geographic area dimension in Hebei Province for the year 2021.

Table 3 Gini coefficient of main health resources allocation in Hebei Province from 2019 to 2021

Year	population distribution			Distributed by geographical area		
	Medical institutions	Hospital beds	Medical personnel	Medical institutions	Hospital beds	Medical personnel
2019	0.093	0.051	0.066	0.355	0.344	0.368
2020	0.092	0.050	0.061	0.346	0.348	0.373
2021	0.090	0.059	0.057	0.343	0.344	0.372

3.3.2. The Lorenz curves

The Lorenz curves for the allocation of healthcare resources in Hebei Province from 2019 to 2021 reveal that the fairness status, as depicted by the curves, is more favorable when resources are allocated based on the population dimension compared to the allocation based on geographic area dimension, as illustrated in Figure 1 and Figure 2. The fairness of Lorenz curves for healthcare resource allocation based on population is relatively similar, while among

the Lorenz curves representing allocation based on geographic area, the fairness of healthcare technical personnel allocation is the least favorable.

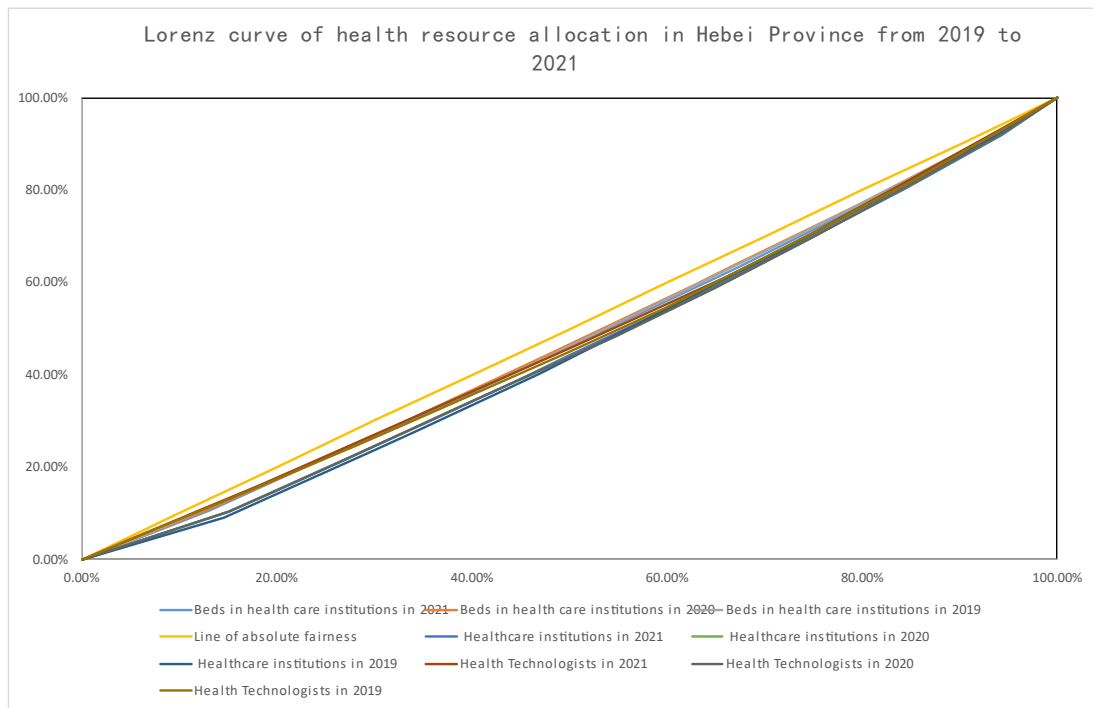


Figure 1 Lorenz curve of health resource allocation in Hebei Province from 2019 to 2021

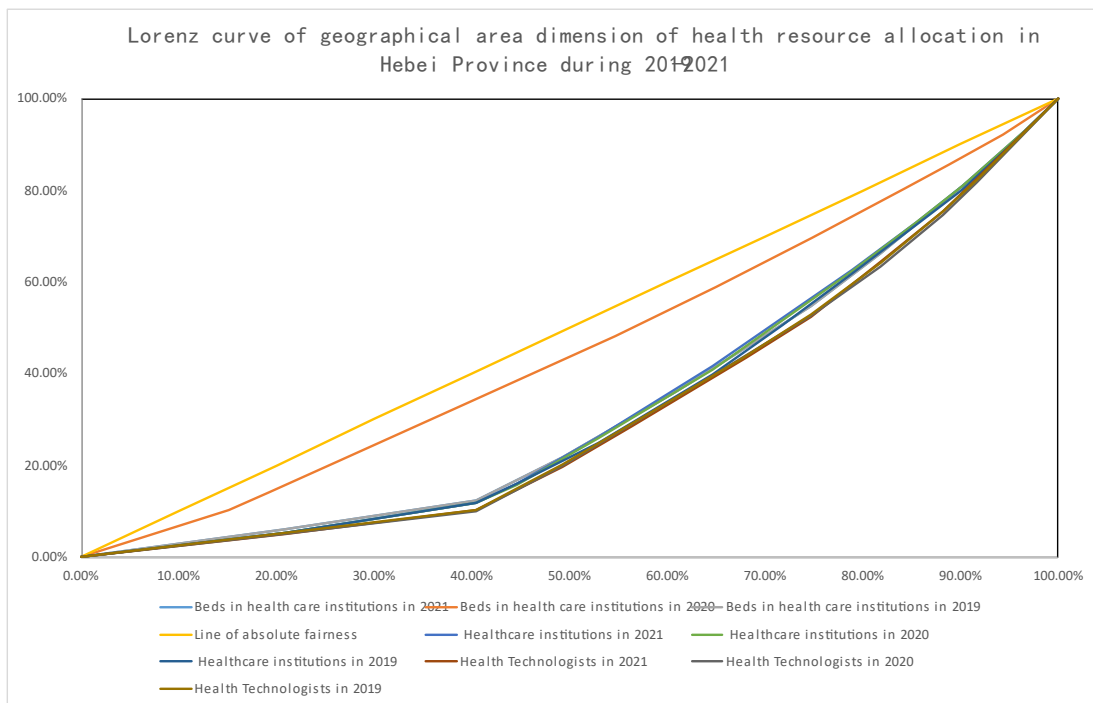


Figure 2 Lorenz curve of geographical area dimension of health resource allocation in Hebei Province during 2019-2021

4. Discussion

4.1. Total Growth, yet Insufficient Allocation of Healthcare Resources

In recent years, with the further development needs of economic reforms and the continuous increase in government financial inputs, the medical and health service system in Hebei Province has experienced rapid development and improvement. The number of medical and health institutions, beds in medical and health institutions, and the total allocation of healthcare technical personnel have increased year by year. However, the level of healthcare resource allocation in Hebei Province remains below the national average during the same period. The total investment is still insufficient, failing to meet the requirements of high-quality economic and social development and the increasingly diverse healthcare needs of the people. The structure and distribution of medical and health resources are not entirely rational, with the number of medical and health institution beds per thousand people in Hebei Province lower than the national average. Moreover, regional disparities persist, with relatively weak capabilities at the grassroots level and shortcomings in the public health system[10].

4.2. Gini Coefficient Shows Fluctuating Trends

Exploring the fairness of healthcare resource allocation in Hebei Province based on population and geographic area dimensions, it is found that the Gini coefficients for both dimensions exhibit fluctuating trends. The Gini coefficients for healthcare resource allocation based on the population dimension are all < 0.1 , indicating a state close to absolute fairness. In contrast, the Gini coefficients for healthcare resource allocation based on geographic area distribution range between 0.3 and 0.4, suggesting a state of normal fairness but with significant room for improvement. Overall, from 2019 to 2021, the allocation of healthcare resources in Hebei Province is relatively fair, with good fairness in healthcare resource allocation.

4.3. Large Disparity between Gini Coefficients of Population and Geographic Dimensions

The Gini coefficient for healthcare resource allocation based on geographic area distribution is higher than that based on population distribution. The fairness of healthcare resource allocation in Hebei Province is better in terms of population distribution than geographic dimensions, indicating that the fairness of healthcare resource allocation in Hebei Province is not fully balanced. Regarding the geographic area dimension, the structure of healthcare resource allocation in Hebei Province still needs improvement.

5. Result

The Hebei provincial government should continue to improve the financial investment mechanism, based on the actual allocation of health resources to establish a medical and health service system that aligns with the requirements of economic growth and social development[11].

There is a need to deepen the coordinated development strategy of the Beijing-Tianjin-Hebei region, strengthen the policy coordination and development of medical and health services among different areas in the Beijing-Tianjin-Hebei region. It is important to incorporate the excellent management experience from Beijing and Tianjin, leverage their abundant medical and health resources to promote collaborative efforts in the region. Exploring coordinated establishment of medical and health institutions across the Beijing-Tianjin-Hebei region aims to improve the optimization and shared utilization of medical and health resources, seeking higher levels of coordination to enhance residents' well-being and promote the overall development of the Beijing-Tianjin-Hebei region[12].

In the process of deepening the strategies of new urbanization and rural revitalization, health administrative departments should establish a dynamic balance mechanism. Scientific and reasonable planning of health resource allocation should be implemented to enhance the geographical fairness and accessibility of health resource allocation. This can be achieved through a combination of setting fixed medical service points and utilizing mobile diagnosis and treatment by family doctors, thereby expanding the coverage of health services[13].

To optimize the medical service model, efforts should be accelerated to promote the development of "Internet + healthcare" models. Leveraging the nationwide coverage of telemedicine networks, reinforcing the internal resource balance within medical alliances is crucial [14]. This will elevate the level of equalization in medical and health services, ensuring that the basic medical service needs of urban and rural residents can be met with high quality. Seizing the opportunities presented by the new round of technological revolution and industrial transformation, it is essential to optimize the structure of high-quality medical resource allocation and expedite expansion and layout. The structure of medical and health resources across the province should be optimized, with city and county-level resources being reasonably constructed and distributed based on population size and service radius. Implementing regional planning and balanced optimization for cities and counties will enhance the basic service and guarantee capabilities of the healthcare system in Hebei province.

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