Risk Management and Healthcare Policy

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ORIGINAL RESEARCH

Regional Differences, Distributional Dynamics and Spatial Convergence of Pharmacist Human Resources in China: A Healthcare Tiers Difference Perspective

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Purpose: This study aims to analyze the regional and hierarchical disparities in the distribution of pharmacist human resources in China from 2012 to 2022, with the goal of identifying underlying trends and challenges. The findings are intended to serve as a basis for optimizing the equitable and efficient allocation of pharmacist resources to better support healthcare system development.

Patients and Methods: Data were collected from the China Health Statistics Yearbook and China Statistics Yearbook. The number of pharmacists per 1,000 population was selected as a measure of equity in pharmacist allocation, and Dagum's Gini coefficient, kernel density estimation method and spatial β-convergence model were utilized to analyze the regional differences and convergence trends of pharmacist resource allocation in Chinese hospitals and primary health care organizations.

Results: The findings reveal that while the overall allocation of pharmacist resources has improved, significant discrepancies remain. The mean number of hospital pharmacists was approximately twice that of primary care centers, with the most pronounced disparity observed in the central region. Regional disparities show declining trends in hospitals but widening gaps in PHCs, particularly in the eastern region. Kernel density results highlight improvements in pharmacist distribution but also reinforce advantages for High-resource provinces, especially at the hospital tier. Spatial analysis indicates significant clustering effects in pharmacist allocation, though these effects have weakened over time. Notably, absolute and conditional β-convergence trends are observed, with faster convergence rates in hospitals compared to PHCs and distinct regional variations in convergence speed.

Conclusion: Since 2012, the allocation of pharmacists' human resources in China has improved, with regional disparities showing signs of reduction. However, hierarchical disparities remain a significant issue that requires further attention, particularly in the central region. To address these challenges, it is essential to increase investment in primary healthcare institutions, with a focus on strengthening pharmacist staffing, improving infrastructure, and enhancing the capacity of pharmacy services at the grassroots level.

Keywords: pharmacists, health resource allocation, primary healthcare institutions, regional disparities, β convergence

Introduction

As the core technical force of China's healthcare service system, the optimal allocation of pharmacists' human resources is not only crucial for ensuring medication safety and improving healthcare quality but also serves as a key measure in achieving the goal of health equity. The World Health Organization emphasized in its Global Strategy for Human Resources for Health[1] that the global density of healthcare personnel, including pharmacists, is generally insufficient—particularly in low-income countries and rural areas—leading to significant bottlenecks in medication accessibility and safety. In China, adverse drug reactions (ADRs) result in approximately 2.5 million hospitalizations annually, with 500,000 classified as serious ADRs and around 190,000 deaths.[2] On the other hand, studies have demonstrated that optimization of patients' medication regimens can significantly reduce healthcare costs.[3] Pharmacists thus play an essential role in ensuring rational and safe medication use while simultaneously reducing healthcare expenses.

Received: 16 April 2025
Accepted: 2 August 2025
Published: 24 August 2025

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Since the initiation of the 2009 healthcare reform in China, the human resources for pharmacists have grown considerably, with their numbers increasing from 342,000 in 2009 to 531,000 in 2022—a 55.26% increase. However, the growth rate of pharmacists' human resources and their proportion within healthcare professionals remain notably lower than other healthcare categories. Additionally, a serious shortage persists in healthcare institutions, where only 45% of the nation's pharmacists are responsible for approximately 73% of pharmacy service workloads.[4] Furthermore, due to regional disparities in development, China faces challenges in achieving balanced allocation of pharmacists' human resources across different regions and healthcare tiers. At the same time, there have been significant changes in the factors affecting the distribution of human resources for health, changes that have, to some extent, exacerbated regional differences in the allocation of health resources. There has been a gradual shift from a single administratively-dominated to a diversified pattern, with the early distribution being heavily influenced by administrative factors, and with the development of the market economy, economic and geographic factors have gradually become dominant, with developed regions attracting large numbers of medical personnel and less developed regions experiencing a relative lack of resources. In addition, the aging population and rising burden of chronic diseases further exacerbate these challenges, creating a widening gap in the demand for pharmacy services. Addressing the uneven regional and hierarchical distribution of pharmacists' human resources has thus become a critical research issue for both the Chinese government and academic scholars.

Since 2009, the Chinese government has undertaken a new round of healthcare system reform, with primary objectives centered around reducing urban-rural and regional disparities in health resources and promoting equalization of basic public health services. In 2015, efforts were intensified to strengthen the primary healthcare system and implement a tiered diagnosis and treatment system that aims to distribute healthcare resources more evenly across various healthcare institution levels.[5] The emphasis on equalization of basic public health services was reaffirmed in the Healthy China 2030 strategic outline. By March 2023, the government released the Opinions on Further Improving the Medical and Health Care Service System, which detailed staffing standards for specialized public health institutions, improved pharmacy service quality, and enhanced drug supply security measures.

Considerable scholarly attention has been directed toward equitable allocation of healthcare resources. Studies have analyzed fairness at national and regional levels using approaches such as Lorenz curves, Gini coefficients, and Theil indices, revealing disparities in healthcare systems both nationally and within specific provinces.[6–11] Chen et al[12] posited that these disparities in China primarily stem from imbalances in economic development and population distribution. Other researchers have investigated the efficiency of health resource allocation through methods like Data Envelopment Analysis (DEA) and Malmquist models, uncovering inefficiencies that hinder the service capacity of healthcare human resources.[13,14]

In terms of pharmacists' human resource allocation, Ni et al[15] applied metrics such as Gini coefficients and Theil indices to explore manpower distribution, while Wei et al[16] employed the Vector Autoregression (VAR) model to identify factors affecting pharmacists' growth, finding that hospital visit numbers, per capita healthcare expenditure, and per capita GDP significantly influence the development of pharmacists' resources. Wu et al[17] constructed two models—the pharmacy service demand method and the economic indicator method—to estimate pharmacist demand in healthcare institutions. Zhou et al[18] utilized agglomeration models to assess the equilibrium of pharmacists' human resource allocation, while Qiao et al[19] and Zhu et al[20] employed spatial analysis methods to examine the geographic distribution characteristics of pharmacists. He et al[21] further applied VAR models and Gini coefficients to analyze disparities in pharmacists' human resources in Tianjin, identifying significant spatial autocorrelation in pharmacist distribution.

Although these studies have contributed valuable insights, they primarily focus on the fairness and spatial effects of pharmacists' human resource allocation, with limited exploration of regional and tiered differences. Moreover, existing studies largely treat pharmacist allocation on a single-tier basis, neglecting disparities across different healthcare system levels (eg, tertiary hospitals versus primary healthcare institutions). Failure to consider these tiered differences may lead to oversimplified conclusions and hinder accurate assessments of pharmacist shortages across healthcare tiers.

In summary, while previous literature has addressed fairness and spatial distribution issues in pharmacists' human resource allocation in China, there remains a gap in research concerning regional and tiered disparities, as well as in-depth analyses of spatial relationships. To address these shortcomings, this study employs the Dagum Gini coefficient, kernel density analysis, and spatial β-convergence models to comprehensively examine regional differences, dynamic evolution, and convergence trends in pharmacists' human resource allocation across two tiers: hospitals and primary healthcare institutions (PHC). This study provides valuable insights into the distribution and allocation of pharmacist resources in China, underscoring the critical need for targeted strategies to address disparities and support primary healthcare institutions in achieving equitable access to pharmacist services.

Materials and Methods

Data Sources

In this paper, pharmacists per 1,000 population are used as the base metric for all subsequent calculations. Specifically, the total number of pharmacists is derived from the China Health and Health Statistics Yearbook (2018–2023), the China Health and Family Planning Statistics Yearbook (2016–2017), and the China Health Statistics Yearbook (2013–2015). Population data, as well as data for control variables, are obtained from the China Statistical Yearbook (2013–2023).

The study period is defined as 2012–2022, and the spatial scope focuses on 31 provinces, autonomous regions, and municipalities directly under the central government in mainland China (excluding Hong Kong, Macao, and Taiwan). For regional analysis, the paper employs the commonly accepted division of China into three major economic zones: eastern, central, and western regions. Specifically: Eastern Region: Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, and Hainan; Central Region: Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, and Hunan; Western Region: Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, and Tibet.

Methods

Dagum Gini Coefficient

The traditional Gini coefficient and Dagum Gini coefficient both measure inequality, but differ in analytical capacity. While the traditional approach effectively quantifies income inequality within homogeneous populations, it cannot identify disparity sources in complex cross-regional contexts. In contrast, the Dagum Gini coefficient provides methodological improvements that enable precise decomposition of regional imbalances. This advanced approach proves particularly valuable when examining inequalities across geographical regions, demographic subgroups, or national boundaries, as it facilitates nuanced analysis of contributing factors.[22] In this paper, Dagum's Gini coefficient and its decomposition method are utilized to analyze the disparities in the allocation of pharmacists' human resources across various levels in China. This method decomposes the overall disparity into three components: intra-regional disparity, inter-regional disparity, and hypervariable density (hypervariable density quantifies the contribution of resource distribution overlaps between differentially ranked regions to the aggregate imbalance, capturing how disparities between high- and low-resource provinces influence overall inequality when their endowment distributions intersect).[23] The specific formula is shown below:

$$G = \frac{\sum_{a=1}^{m}\sum_{b=1}^{m}\sum_{i=1}^{n_a}\sum_{r=1}^{n_b}|y_{ai} - y_{br}|}{2n^2\bar{y}} \tag{1}$$

$$G = G_i + G_b + G_t \tag{2}$$

In Equation (1), G represents the overall Gini coefficient, where a larger value indicates greater disparities in the allocation of pharmacists' human resources. The parameters are defined as follows: mm denotes the number of regional divisions, n_a is the number of provinces in the ath subregion, n_b is the number of provinces in the bth subregion, y_{ai} represents the pharmacists' human resource allocation in the ith province within the aa-th subregion, y_{br} refers to the allocation in the rth province within the bth subregion, n is the total number of provinces, and $\bar{y}$ is the mean value of pharmacists' human resource allocation across all provinces; In Equation (2), G_i, G_b, and G_t, represent the contributions of intra-region variation, inter-region variation, and contribution of hypervariable density, respectively. These components are used to quantify the contributions of intra-regional disparities, inter-regional disparities, and cross-regional interactions to the overall variation in the allocation of pharmacists' human resources.[24] For details on the specific decomposition of the formula, refer to the related study by Dagum.[25]

Kernel Density Estimation

The kernel density estimation method was employed to analyze the distribution dynamics and trends in the allocation of pharmacists' human resources in China. The formula is:

$$f(x) = \frac{1}{Nh}\Sigma_{i=1}^{N}k\left(\frac{x_i - x}{h}\right) \tag{3}$$

Equation (3) defines the parameters as follows: N represents the number of samples, h denotes the bandwidth, x is the mean value, and $f(x)$refers to the kernel function. The kernel density curve provides critical insights into the research subject during the study period, including its distribution position, trend, and extensibility. Specifically, the distribution position reflects the growth of pharmacists' human resource allocation, where higher values indicate a higher allocation level. The distribution trend reveals disparities in pharmacists' human resource allocation, as indicated by the height of the wave peaks, while the number of peaks identifies the degree of polarization in the allocation. Finally, the distribution extensibility captures the gap between the highest and lowest allocation levels among provinces, offering insights into regional differences in pharmacists' resource distribution.[26]

Global Moran's Index

The global Moran index can judge the spatial distribution characteristics between variables from the significance level, in which the positive significance sign implies that there is a centralized distribution characteristics between variables, and the negative significance characteristics represent the dispersed characteristics. The size of the global Moran index can also judge the size of the spatial link between variables, the closer the positive value is to 1, the stronger the concentration, the closer the negative value is to −1, the stronger the dispersion.[27] The formula is:

$$I(d) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}(x_i - \overline{x})(x_j - \overline{x})}{S^2\sum_{i=1}^{n}\sum_{j=1}^{n}W_{ij}} \tag{4}$$

In Equation (4), $x_i$is the observed value of region i, x_j is the observed value of region j, and $W_{ij}$is the spatial weight matrix with spatial adjacency of 1. $I(d)$>0 is a positive spatial correlation, which indicates that there is a significant positive spatial correlation of pharmacists' human resource allocation.[28]

Spatial β Convergence Model

The concept of traditional convergence originates from the neoclassical school of economic growth theory and encompasses three primary types: absolute convergence, conditional convergence, and club convergence. Absolute convergence assumes that all regions possess identical initial endowments, whereby less developed regions exhibit higher growth rates, allowing them to catch up with more developed regions over time and eventually achieve a relatively stable state of development. Conditional convergence expands on absolute convergence by incorporating variations in initial endowments, acknowledging that differences in these factors can significantly affect the rate and likelihood of convergence.[29] However, in the context of the spatial distribution of pharmacists' human resources across regions in China, the traditional β-convergence model fails to account for spatial correlation effects that may exist between these regions. To address this limitation, this study integrates spatial correlation into the traditional β-convergence model, drawing on the methodology proposed by Castellanos-Sosa et al.[30] Specifically, the Spatial Autoregressive (SAR) model, Spatial Error Model (SEM), and Spatial Durbin Model (SDM) are employed to conduct a spatial convergence analysis. The formula is:

$$SAR : \Delta lnY_{i,t+1} = \alpha + \beta lnY_{i,t} + \gamma X_{i,t} + \rho\sum_{j=1}^{n}w_{i,j}\Delta lnY_{i,t+1} + c_i + \mu_t + \varepsilon_{i,t} \tag{5}$$

$$SEM : \Delta lnY_{i,t+1} = \alpha + \beta lnY_{i,t} + \gamma X_{i,t} + c_i + \mu_t + \varepsilon_{i,t} \tag{6}$$

Table 1 Definition and Descriptive Statistics of Control Variables

Variable	Variable Definition	Observes	Maximum Value	Minimum Value	Standard Deviation	Mean
LnGDP	GDP per capita	341	12.15	9.85	0.44	10.90
IVH	Government health expenditure/total government payments	341	1.35	0.11	0.20	0.29
URB	Urban population/total population	341	0.14	0.04	0.02	0.08
GOV	Government expenditure/total GDP	341	0.90	0.23	0.13	0.60
LnPOP	Population density	341	8.28	0.94	1.49	5.32

$$SDM : \Delta InY_{i,t+1} = \alpha + \beta lnY_{i,t} + \gamma X_{i,t} + \psi \sum_{j=1}^{n} w_{i,j} lnY_{j,t} + \rho \sum_{j=1}^{n} w_{i,j} \Delta lnY_{i,t+1} + \phi \sum_{j=1}^{n} w_{i,j} X_{j,t} + c_i + \mu_t + \varepsilon_{i,t} \quad (7)$$

In equations (5–7), $InY_{i,t+1}$ is the observation of the *ith* region in period *t*, $\varepsilon_{i,t}$represents an independent and identically distributed residual term, and $\varepsilon_i$is the error term with spatial autocorrelation. ρ is the spatial autoregression coefficient, γ is spatial autocorrelation coefficient of error item, and ψ is the spatial lag coefficient of $InY_{i,t}$. In addition, $w_{i,j}$ is the element in spatial weight matrix, $\sum_{j=1}^{n} w_{i,j} \Delta lnY_{i,t+1}$ denotes the spatial interaction of $\Delta lnY_{i,t+1}$, c_i and μ_t represent province and time-fixed effects. γ is the coefficient of control variable. ϕ is the spatial lag coefficient of control variable.[31] $X_{j,t}$ is the control variable, The main components are the level of economic development (*GDP*), the level of investment in health (*IVH*), the urbanization rate (*URB*), the population density (*POP*), and the level of government intervention (GOV),[32–34] The definitions and data sources for these variables are shown in Table 1. if β<0, it means that there isβconvergence.

Results

Temporal Dynamics of Pharmacists' Human Resource Allocation

As shown in Figure 1, the human resources of pharmacists in China experienced substantial growth between 2012 and 2022, with the total number increasing from 358,511 to 504,401, reflecting an average annual growth rate of 3.4%. At different institutional levels, pharmacist resources in Chinese hospitals increased from 231,249 to 332,849 during the same period, with an average annual growth rate of 3.7%. Meanwhile, pharmacist resources in PHC rose from 127,262 to 171,552, yielding an average annual growth rate of 3%. Furthermore, the disparity between hospitals and PHCs exhibited

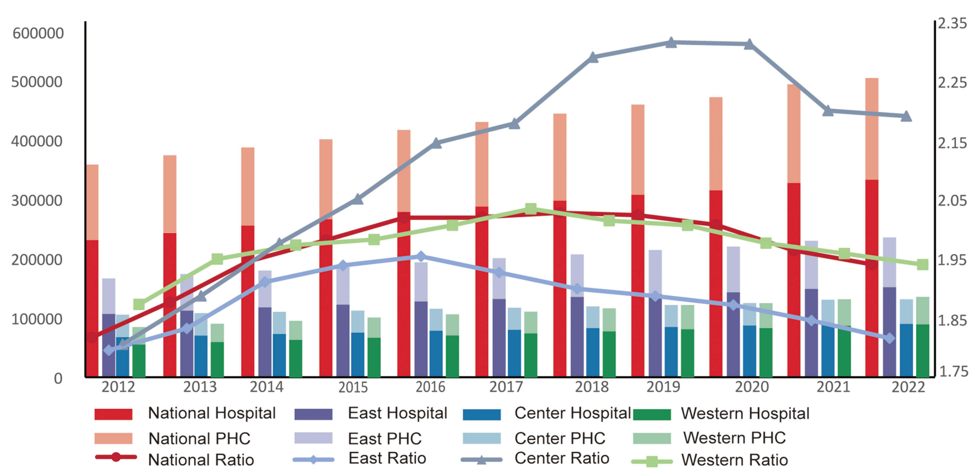


Figure 1 Regional Differences in Pharmacists' Human Resources in China.

a fluctuating upward trend, rising from 1.82 in 2012 to a peak of 2.03 in 2018, before slightly declining to 1.94 between 2019 and 2022. This shift can be attributed to two post-pandemic policy developments in China. First, governments at all levels substantially increased investments in health resources, with particular emphasis on primary healthcare institutions. Second, nationwide implementation of the medical consortium model enhanced the integration of grassroots facilities, promoting the redistribution of pharmacist human resources to primary care settings and ultimately reducing inter-tier disparities across healthcare organizations.

Overall, despite the relatively rapid development of pharmacist human resources in China, the growth rate and total quantity remain significantly higher at the hospital level compared to PHCs. The disparity between pharmacist resources across different healthcare tiers has widened. However, the outbreak of the COVID-19 pandemic has notably altered China's health resource allocation patterns and affected the trajectory of this discrepancy.

From a regional perspective, the total pharmacist resources across different tiers were substantially higher in the eastern region, followed by the central and western regions. Specifically, pharmacist resources in the eastern region increased from 167,161 to 236,291, reflecting an average annual growth rate of 3.5%. The central region saw an increase from 106,059 to 132,027, with an average annual growth rate of 2.2%, while the western region demonstrated the most rapid growth, expanding from 85,291 to 136,083, with an average annual growth rate of 4.8%. Notably, the western region surpassed the central region in resource quantity in 2021. Regarding tier disparities, all three major regions displayed an initial rise followed by a decline, albeit with differing inflection points: the eastern region peaked in 2016, the western region in 2017, and the central region in 2019. On average, the eastern and western regions maintained a value of 1.97 from 2012 to 2022, whereas the central region recorded a higher average value of 2.12.

Regional Differences and Sources of Differences in Human Resource Allocation for Pharmacists in China

Regional Differences in Pharmacist

As shown in Figure 2A, the Gini coefficient for hospital pharmacist human resource allocation in China decreased from 0.147 in 2012 to 0.103 in 2022, demonstrating a reduction in regional disparities over the study period. Regionally, the eastern, central, and western regions all experienced declines in their hospital pharmacist Gini coefficients: 0.149, 0.083, and 0.14 in 2012 compared to 0.13, 0.053, and 0.081 in 2022, with average annual reduction rates of −1.3%, −4.3%, and −5.2%, respectively. Notably, the eastern region consistently had a higher Gini coefficient than the national average. The central region consistently had the smallest Gini coefficient, whereas the western region exhibited the fastest decline.

As shown in Figure 2B, the Gini coefficient for pharmacist human resource allocation in China's PHCs displayed a fluctuating downward trend, dropping from 0.207 in 2012 to 0.192 in 2021, before slightly rebounding to 0.195 in 2022. This indicates that, while regional disparities in PHC pharmacist allocation have decreased overall, the magnitude of the decline was smaller compared to hospitals. Regionally, significant heterogeneity was observed in PHC pharmacist

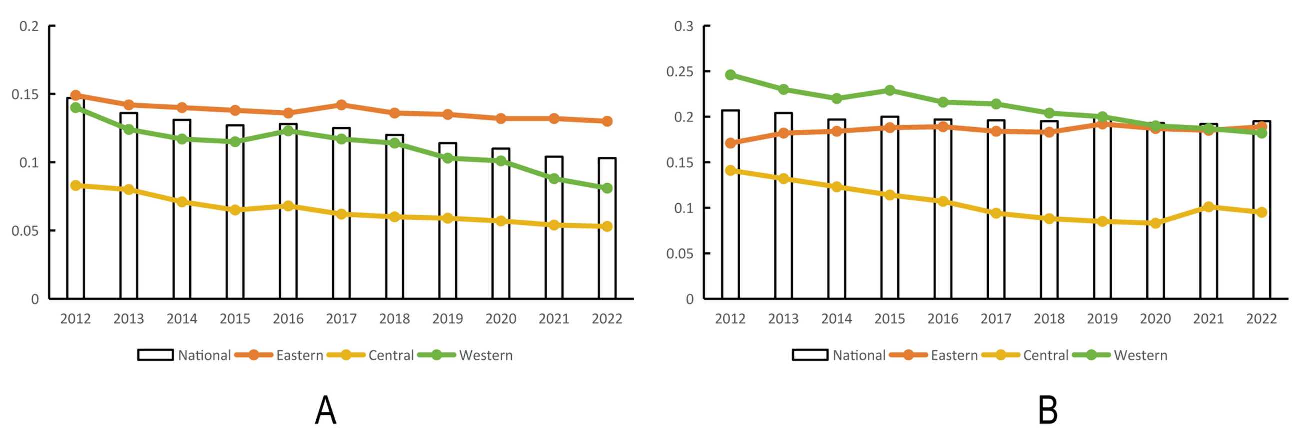


Figure 2 Changes in the Gini Coefficient of Pharmacists' Human Resource Allocation in China. (**A**) Changes in the Gini coefficient of human resource allocation among hospital pharmacists in China, (**B**) Changes in the Gini coefficient of human resource allocation among PHC pharmacists in China.

 https://doi.org/10.2147/RMHP.S534923

human resource allocation. The eastern region exhibited a unique upward trend, with its Gini coefficient rising from 0.171 in 2012 to 0.189 in 2022, reflecting an annual growth rate of 1.0%. In contrast, the central and western regions demonstrated declining trends, with Gini coefficients decreasing from 0.141 and 0.246 in 2012 to 0.095 and 0.182 in 2022, respectively, corresponding to average annual reduction rates of −3.9% and −3.1%.

Overall, regional disparities in pharmacist human resource allocation in both hospitals and PHCs have generally decreased. However, disparities in PHCs remain larger than those at the hospital level, particularly in the eastern and western regions. Economic development disparities between regions are a major contributing factor. For example, in 2012, the western region's weaker economic base made it challenging to allocate sufficient pharmacist resources to PHCs, compounded by lower salaries leading to workforce migration to wealthier areas within the region. Conversely, the eastern region's economic growth (eg, in Zhejiang and Jiangsu provinces in the Yangtze River Delta) provided greater financial capacity for PHC expansion, increasing disparities between provinces within the region.

Interregional Differences in Pharmacist

Figure 3A illustrates the trend of inter-regional differences in human resource allocation for hospital pharmacists in China from 2012 to 2022. Over the study period, all three major inter-regional gaps (Eastern & Western, Eastern & Central, and Central & Western) exhibited a decreasing trend. Between 2012 and 2021, the largest inter-regional gap was observed between the Eastern and Western regions, while in 2022, this shifted to the disparity between the Eastern and Central regions.

Figure 3B 2highlights the trend of inter-regional differences in the human resource allocation of pharmacists in PHCs in China over the same period. Both the Eastern & Western and Central & Western disparities displayed a downward trend, whereas the Eastern & Central disparity showed a significant upward trajectory. During 2012–2013, the Eastern & Central disparity was the smallest among the three pairs of regions. From 2014 to 2017, this disparity became the second largest, while in 2018–2022, it emerged as the most pronounced inter-regional gap.

Sources of Differential Contributions by Pharmacists

Figure 4A hows the sources of contribution to the human resource allocation gap for hospital pharmacists in China from 2012 to 2022. During the study period, disparities in hospital pharmacist allocation were primarily driven by inter-regional disparity, which remained the largest and most stable source of variation, followed by intra-regional disparity and hypervariance density, which was consistently the smallest contributor. Specifically, inter-regional disparities exhibited a fluctuating downward trend from 42.52% in 2012 to 34.76% in 2020, followed by an upward trend from 2021 to 2022, reaching 41.10%. This pattern is consistent with the sources of differences observed in 2012.

Figure 4B resents the sources of contribution to the variance in human resource allocation for PHC pharmacists. During the study period, the disparities in PHC pharmacist allocation showed substantial changes. In general, intra-

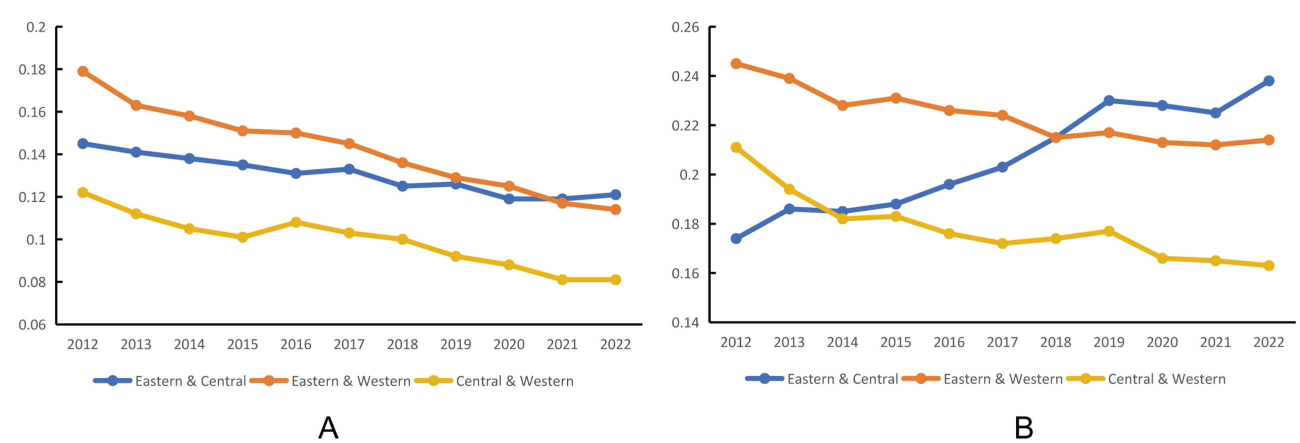
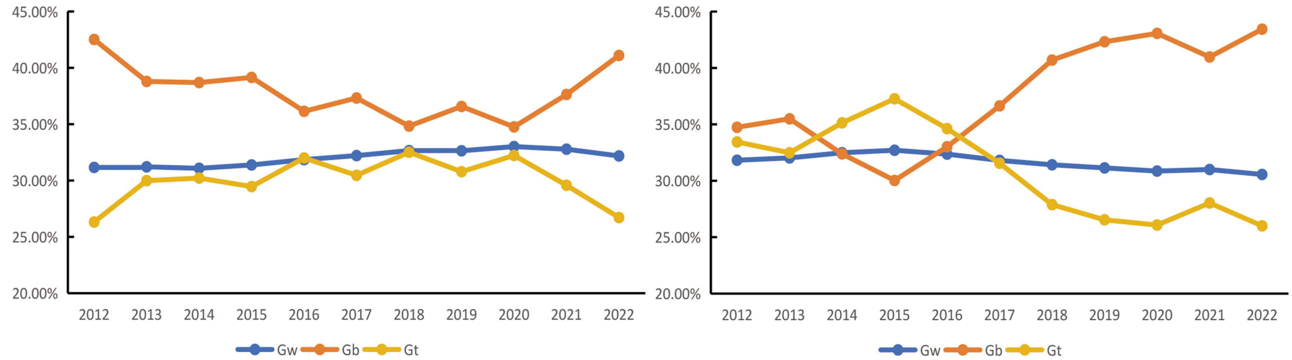


Figure 3 Interregional Differences in Pharmacists' Human Resource Allocation in China. (**A**) Interregional differences in human resource allocation among hospital pharmacists in China, (**B**) Interregional differences in human resource allocation among PHC pharmacists in China.



A3. Hospital contribution rate

B3. PHC contribution rate

Figure 4 Sources of Gini coefficient variance contributions. (**A**) Sources of differences in hospital Gini coefficients, (**B**) Sources of differences in PHC Gini coefficients.

regional gaps remained relatively stable, while inter-regional disparities and hypervariance density fluctuated significantly between 2012 and 2016, alternately becoming the largest source of variation. From 2016 to 2022, inter-regional disparities exhibited a consistent upward trend, increasing from 33.01% to 43.44%, while hypervariance density declined from 34.62% to 26%.

Overall, the disparities in pharmacist human resource allocation for both hospitals and PHCs followed a broadly similar trend: a gradual increase in inter-regional disparity, a decrease in hypervariance density, and relatively stable intra-regional disparity.

Kernel Density Curve Estimates

Kernel Density Profile Analysis of Hospital Pharmacists

Figure 5 illustrates the dynamic evolution of hospital pharmacists' human resource allocation distribution across China and its three major regions during the study period. First, the center point of the overall curves for the country and the three regions gradually shifted to the right, indicating a steady increase in the allocation of pharmacists' human resources.

Second, the main peak height of the distribution curve for the country and the three regions consistently increased, while the curve width narrowed, suggesting a trend of reduced disparity. However, from 2019 to 2022, the peak height of the central and western regions decreased, accompanied by a widening curve width, indicating increased disparities in these regions.

Third, the distribution curves for the national, eastern, and western regions exhibited "right-dragging" characteristics, expanding further to the right. This suggests that provinces with higher levels of human resource allocation strengthened their leading advantage.

Finally, the eastern region transitioned from a single-peak distribution to a distinct bimodal pattern, reflecting a pronounced gradient effect within the region. Conversely, the central and western regions transitioned from multi-peak distributions to single-peak patterns, indicating a weakening of multi-polarization within these regions.

Kernel Density Profile Analysis of PHC Pharmacists

Figure 6 illustrates the dynamic evolution of human resource allocation distribution for PHC pharmacists across China and its three major regions during the study period. First, the center points of the overall curves for China and the three regions gradually moved to the right, indicating a steady increase in the allocation of PHC pharmacists. Second, The height of the main peak of the distribution curve for China and the eastern region declined, while the curve width increased, suggesting a widening disparity. In contrast, the central and western regions showed an increase in peak height and a narrowing of width, indicating a reduction in disparities. However, between 2019 and 2022, disparities in the central and western regions widened slightly, likely influenced by the COVID-19 pandemic. Third, the distribution curves for China, the central, and the western regions exhibited "right-dragging" indicating that provinces with higher levels of human resource allocation experienced better development. The eastern region, however, displayed

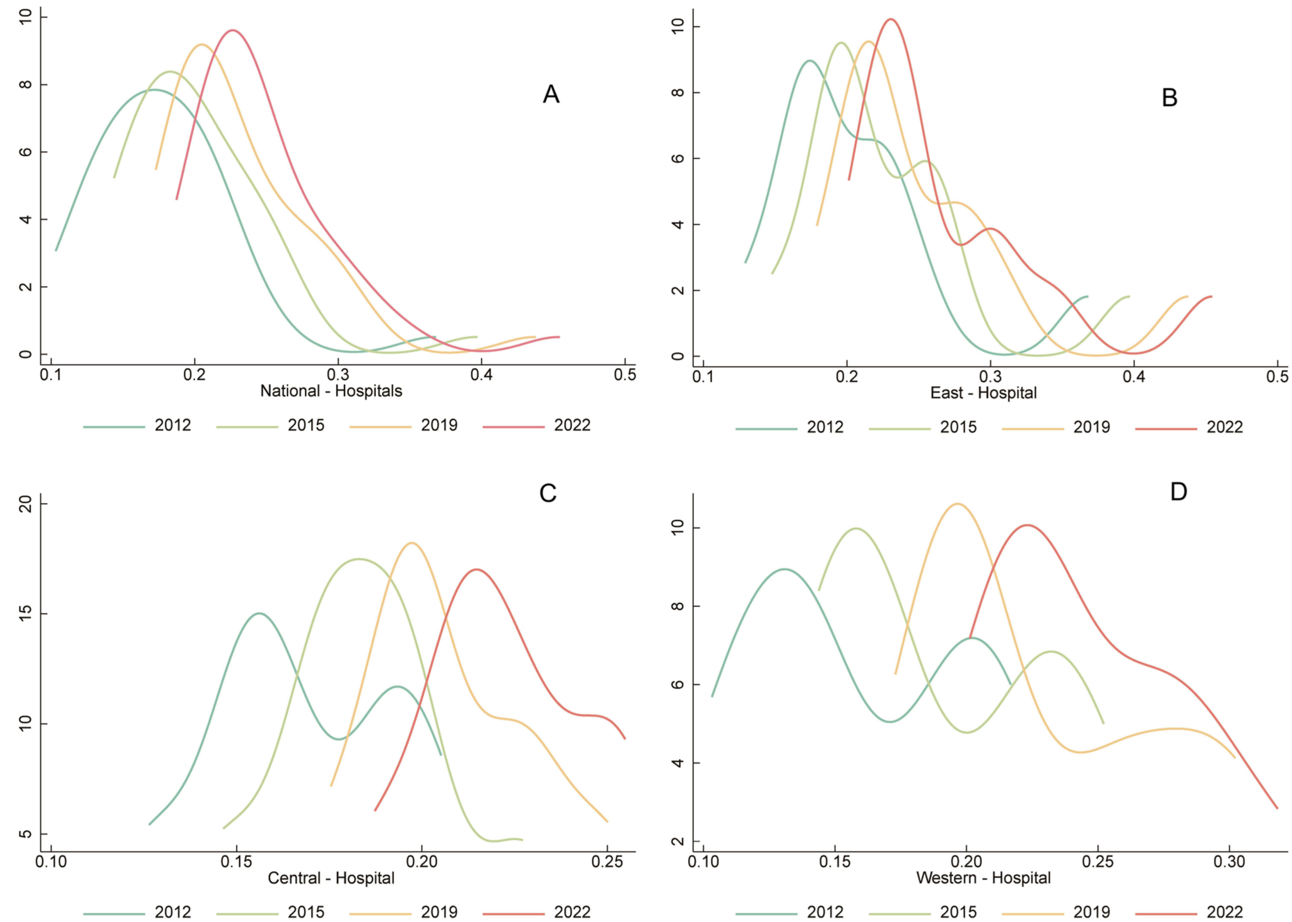


Figure 5 Kernel density distribution of human resource allocation for hospital pharmacists. (**A**) national nuclear density, (**B**) Nuclear density in the eastern region, (**C**) Nuclear density in the central region, (**D**) Nuclear density in the western region.

a coexistence of "right-dragging" and "left-dragging" phenomena, suggesting that the absolute disparity between advantaged and disadvantaged provinces within the region has been increasing. Finally, both the national and eastern regions transitioned from a single-peak to a bi-peak distribution, indicating an increase in multi-polarization. Meanwhile, the central and western regions did not show significant changes in their multi-peak patterns.

Spatial Convergence Analysis of Human Resources of Pharmacists in China

Spatial Correlation Test

Given the theoretical spatial correlation between pharmacist human resource allocation across provinces, spatial econometric analysis was conducted. Using Stata 17 software, the global Moran index for pharmacist human resource allocation in hospitals and PHCs in China was calculated from 2012 to 2022. As shown in Table 2, the global Moran index is positive in all years and statistically significant at the 5% level, indicating that pharmacist human resource allocation in China does not follow a completely random distribution. Instead, it exhibits a positive spatial autocorrelation, meaning that the development of pharmacist human resources in a given province is influenced not only by its own development level but also by neighboring provinces.

From a temporal perspective, the Moran index for both hospitals and PHCs shows a downward trend, suggesting that the spatial clustering of pharmacist human resource allocation is gradually weakening. This decline may be attributed to the uneven regional development in China. As indicated by the kernel density measurements, pharmacist human resource allocation currently displays gradient disparities and tail-dragging phenomena, with provinces developing at varying

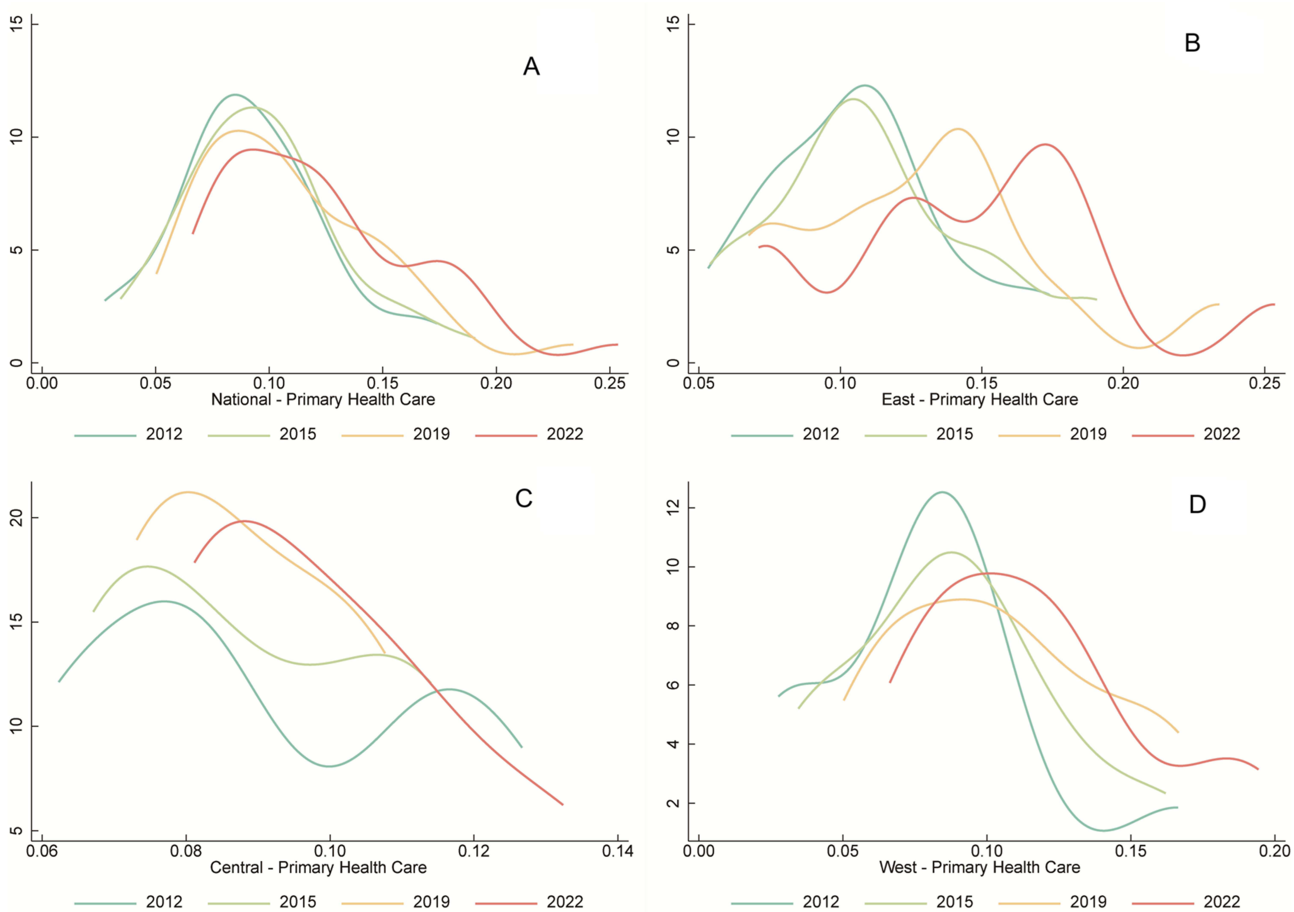


Figure 6 Kernel density distribution of human resource allocation for Primary Health Care pharmacists. (**A**) national nuclear density, (**B**) Nuclear density in the eastern region, (**C**) Nuclear density in the central region, (**D**) Nuclear density in the western region.

speeds. These differences increase overall variability, thereby contributing to the weakening of spatial correlation over time.

Spatial Convergence Model Test

Convergence analysis examines whether there is a catch-up effect in pharmacist human resource allocation across provinces in China. If the allocation of pharmacist human resources across regions demonstrates convergence, it indicates

Table 2 The Spatial Correlation Test Results

Year	Hospitals			PHC		
	I	Z	p - Value	I	Z	p - Value
2012	0.200	2.811	0.002	0.192	2.494	0.006
2013	0.191	2.698	0.003	0.170	2.254	0.012
2014	0.202	2.851	0.002	0.144	1.962	0.025
2015	0.186	2.682	0.004	0.133	1.845	0.032
2016	0.176	2.529	0.006	0.137	1.902	0.029

(*Continued*)

Table 2 (Continued).

Year	Hospitals			PHC		
	I	Z	p - Value	I	Z	p - Value
2017	0.156	2.286	0.011	0.155	2.092	0.018
2018	0.136	2.015	0.022	0.147	2.021	0.022
2019	0.121	1.883	0.03	0.144	1.997	0.023
2020	0.126	1.938	0.026	0.157	2.138	0.016
2021	0.139	2.11	0.017	0.147	2.012	0.022
2022	0.146	2.211	0.014	0.157	2.123	0.017

that the gap between advantaged and disadvantaged provinces will continue to narrow; otherwise, the gap will widen. To explore this, the study employs a spatial β-convergence model to analyze the spatial convergence of pharmacist human resources across China and its three major regions from 2012 to 2022.

Before performing spatial β-convergence regression, the spatial fitness of the model must be tested. Following the research framework of J. P. Elhorst,[35,] the paper uses three key tests: (1) the LM test is conducted based on OLS regression to evaluate spatial error effects and spatial lag effects within the model; (2) the Hausman test determines whether the spatial regression model fits fixed effects or random effects; and (3) the LR test and Wald test assess whether the model is applicable to the spatial Durbin model. As more models are involved in this paper, presenting the test results is more complicated, so only the test method is presented here, if there is a need for the test results can be asked to the corresponding author.

Absolute β Convergence Analysis

Considering the spatial correlation of pharmacist human resource allocation across the nation and within the three major regions—East, Central, and West—this study employs a spatial model to test for absolute β-convergence. As shown in Table 3, the β coefficients for pharmacist human resource allocation in hospitals and PHCs across the country and the three regions are significantly negative. This indicates a tendency toward absolute convergence, meaning that, after

Table 3 Absolute β Convergence Test of Pharmacist Human Resources Allocation

Type	Hospitals				PHC			
	National	Eastern	Central	Western	National	Eastern	Central	Western
	SEM	SDM	OLS	SEM	SAR	SEM	SAR	OLS
β	−0.185***	−0.172***	−0.057***	−0.192***	−0.136***	−0.09**	−0.213***	−0.026*
V	0.02	0.018	0.006	0.021	0.014	0.009	0.024	0.003
T	33.75	36.65	117.09	32.45	47.18	73.33	28.82	260
Likehood	765	319	/	256	606	236	175	/
N	310	110	80	120	310	110	80	120
Spatial	YES	YES	NO	YES	YES	YES	YES	NO
Time	YES	YES	NO	YES	YES	YES	YES	NO

Note: *, **, and *** indicate statistical significance at the levels of 10%, 5%, and 1% levels.
Abbreviation: PHC, Primary health care institutions.

excluding external factors such as economic, social, and geographic influences, regions with lower levels of pharmacist human resource allocation exhibit higher growth efficiencies, allowing them to catch up with high-level regions and ultimately converge to a steady state.

In terms of convergence speed, the national, eastern, and western regions demonstrate faster convergence in pharmacist human resource allocation in hospitals compared to PHCs. Conversely, the central region shows a significantly higher convergence speed in PHCs than in hospitals.

Condition β Convergence Analysis

As shown in Table 4, the β coefficients for the national level and all three regions are negative and statistically significant at the 10% level, suggesting the presence of conditional β convergence in pharmacists' human resource allocation across hospitals and PHCs. This indicates that convergence trends persist even after controlling for economic, institutional, and demographic factors. Specifically, under absolute convergence, the convergence rates of pharmacists' human resource allocation at both national and regional levels were significantly higher in hospitals than in PHCs. Regional rankings of convergence rates differed between healthcare tiers: at the hospital level, the northeast region exhibited the highest rate, followed by central, national, and western regions; whereas at the PHC level, the central region led, followed by national, eastern, and western regions. Notably, the western region consistently demonstrated the lowest convergence rates across both tiers.

From a control variable perspective, GDP exhibited a significantly negative association only at the national hospital level and in the eastern PHC level, suggesting that economic development may paradoxically inhibit convergence. This phenomenon could be attributable to pharmacists' preference for economically advantaged provinces, potentially widening interregional disparities through resource concentration in developed areas.[36] Health investment intensity showed a statistically significant positive association only at the national hospital level, indicating its effectiveness in promoting pharmacist resource convergence. Conversely, at the PHC level, a significantly negative association emerged in the central region, likely due to governmental prioritization of hospital-level infrastructure over PHC development.[37]

Table 4 Conditional β Convergence Test of Pharmacist Human Resources Allocation

Type	Hospitals				PHC			
	National	Eastern	Central	Western	National	Eastern	Central	Western
	SDM	SDM	OLS	OLS	SEM	SEM	SEM	OLS
β	−0.263***	−0.442***	−0.306	−0.234***	−0.150***	−0.082*	−0.234***	−0.262*
LnGDP	−0.109***	−0.061	−0.119	−0.086	0.063	−0.273***	0.034	0.035
IVH	0.341*	−0.104	−0.023	0.678	−0.283	−0.113	−1.139*	1.341
UBR	0.388**	0.293*	1.240	0.158	−0.256*	−0.191	0.294	−0.072
GOV	−0.272***	−0.016	−0.222	−0.286*	−0.151*	−0.031	0.364	0.137
LnPOP	−0.109*	−0.433***	−0.162	−0.287	−0.119	0.004	0.081	0.012
V	0.031	0.058	0.036	0.026	0.016	0.008	0.027	0.003
T	22.71	11.88	18.94	25.98	42.50	80.65	25.99	260.5
Likehood	765	335	/	/	611	239	179	/
N	310	110	80	120	310	110	80	120
Spatial	YES	YES	NO	YES	YES	YES	YES	NO
Time	YES	YES	YES	YES	YES	YES	YES	NO

Note: *, **, and *** indicate statistical significance at the levels of 10%, 5%, and 1% levels.
Abbreviation: PHC, Primary health care institutions.

Urbanization rate positively correlated with convergence at both national and eastern hospital levels, yet showed negative associations at the PHC level (except in the central region). This dichotomy may reflect urban healthcare systems' capacity to attract PHC resources through superior facilities, particularly problematic in highly urbanized areas. The central region's contrasting pattern could stem from its moderate urbanization allowing balanced resource distribution.[38] Government intervention demonstrated significantly negative effects on hospital-level convergence in both national and western regional analyses, potentially linked to policy emphasis on service scale expansion over workforce retention, driving pharmacist migration to private sectors.[39] Population density showed significantly negative associations with hospital-level convergence only at the national level and in the eastern region, likely exacerbated by rigid staffing quotas under China's health ministry regulations (eg, mandatory 8% pharmacist-to-staff ratio in general hospitals). These institutional constraints, combined with lagged workforce adjustments amidst growing demand, may dilute per capita resources and accelerate staff turnover.[40]

Discussion

Disparities Among Different Tiers of the Healthcare System Represent a Critical Determinant in the Allocation of Health Resources

Currently, there are more studies on the equity of China's health system, such as Chai et al,[41] Ao et al[42] and Guo et al[16] who made studies on the equity of China's overall health human resources, rural health resources and pharmacist manpower, respectively, and concluded that the equity problems of China's health resource allocation are widespread, and that the problems facing them are consistent across different healthcare systems. However, this study found that in the same health resources, there are large differences in the allocation of health resources at different levels, firstly, different levels of healthcare systems show different characteristics in regional differences, and secondly, the same factor does not have a consistent impact on different levels of healthcare systems. This is similar to Bin et al,[20] but they only explored the equity of pharmacist resource allocation in urban and rural area distribution from the perspective of spatial correlation, and concluded that the differences in pharmacist resource allocation mainly stemmed from the Chinese government's negligence of geographic distribution equity. However, this study used the spatial β-convergence model to further investigate that different tiers of healthcare systems have significant differences in the speed of convergence, and that differences from different levels of healthcare systems are also important factors affecting pharmacist resource allocation in China. Kai et al[43] studied a single city, which also verified this phenomenon, and found that the human resources of pharmacists at the hospital level were significantly better than those at the primary care level. This suggests that differences in healthcare systems at different levels are widespread in China, and that distinguishing between the problems faced in different levels of healthcare systems is more conducive to narrowing the problem of regional differences in health resource allocation in China.

Marked Differences in the Allocation of Health Resources Between Medical Tiers and Regions

Despite substantial growth in China's pharmacist workforce over the past decade, persistent structural disparities across healthcare tiers and regions remain evident. Pharmacist distribution remains heavily skewed toward hospitals, exhibiting an average disparity of approximately twofold compared to PHCs. This situation runs counter to the pyramid structure advocated for the rational allocation of healthcare resources, where primary healthcare institutions should hold a dominant position in resource allocation. Instead, the significant dominance of hospitals creates an imbalance in resource distribution, reducing the efficiency of healthcare services and making it difficult to meet the population's demand for basic pharmacy services.[44,] Regional heterogeneity in these disparities is pronounced: the economically advanced eastern region demonstrates relatively smaller hospital-PHC gaps, whereas the western region's lower economic development correlates with wider disparities. The central region confronts compounded challenges including elevated population density coupled with moderate economic development, exacerbating its hierarchical resource disparities. China's 13th Five-Year Plan (2016–2020) contributed to mitigating hierarchical disparities through its Basic Public Healthcare Services Equalization Initiative, which prioritized resource redistribution to PHCs.[40] While the COVID-19 pandemic accelerated short-term resource reallocation across tiers. This change is driven by the government's substantial investments and temporary recruitment practices implemented in response to the COVID-19 pandemic. However, with the decline in local revenues and the conclusion of the pandemic, economically disadvantaged regions may find it challenging to sustain increased investments or may even face reductions in healthcare funding over the long term. This could further widen the gap between economically advantaged and disadvantaged localities. Therefore, efforts to increase healthcare staffing in the primary healthcare system should not focus solely on short-term investments but instead prioritize establishing a stable and sustainable growth mechanism.

Regional Differences with Significant Hierarchical Heterogeneity

Nationwide regional disparities in pharmacist distribution demonstrated a declining trajectory during the observation period (2012–2022), yet significant stratification-linked heterogeneity persists. Hospital-level disparities exhibited consistent contraction across all regions, aligning with Ni et al's findings.[15] Conversely, PHC-level disparities displayed divergent patterns: eastern PHC-level disparities displayed an upward trajectory, contrasting with narrowing gaps in central and western regions—a finding discordant with Bin et al's western-focused equity analysis.[20] Kernel density estimation revealed strengthened primacy effects in eastern hospital clusters, while PHC-level analysis exposed widening absolute gaps between advantaged (eg, Shanghai, Zhejiang) and disadvantaged provinces. This siphoning phenomenon intensifies intra-regional pharmacist resource polarization, particularly affecting western rural areas.[45] Notably, the COVID-19 pandemic disproportionately impacted PHC resources, accelerating regional disparity expansion in central-western regions during 2019–2022.

Pharmacist Human Resources in PHC are Facing Double Siphoning

From the previous analysis, it is evident that pharmacist human resources in this PHC are simultaneously affected by the siphoning effect of dominant provinces and high-level medical institutions. This leads to a loss of PHC pharmacist human resources and exacerbates regional imbalances, a phenomenon amplified during the COVID-19 pandemic and other challenges. Despite increased investment and infrastructure development by the Chinese government in primary healthcare institutions, governmental interventions, based on control variables, exhibit an inhibiting effect on PHCs' convergence. This is primarily because local government interventions in PHCs are often capital-focused, and economically developed regions possess stronger capabilities and efficiency in utilizing governmental funds, thereby amplifying their advantages in resource utilization. The efficiency advantage in economically developed regions further exacerbates the siphoning effect of advantaged provinces.[46] Moreover, the Chinese government's focus on hospital-level healthcare infrastructure intensifies the siphoning effect on PHC pharmacist human resources, exacerbating PHC instability.[47] At the same time, the Chinese government has made various efforts to address this issue. For example, Chongqing Municipality has explicitly included a pharmacy workforce growth plan in its government work objectives. It has allocated special funds and established separate recruitment channels for pharmacists. Additionally, it has implemented a unified personnel management system, integrating pharmacists from both hospitals and PHCs while appointing them based on specific needs. These measures have proven effective in improving local pharmacist human resources and enhancing the pharmacy service capacity of PHCs.

Suggestions

Overall, China's human resource allocation for pharmacists faces challenges such as an insufficient total number of pharmacists, increasing pressure on pharmacist services, and significant regional and hierarchical disparities. To address these issues, the Chinese government should formulate a medium- and long-term plan for the development of pharmacist human resources with reasonable growth targets. This plan should include encouraging the establishment of new pharmacy colleges and universities in the central and western regions and expanding enrollment in pharmaceutical programs to increase the overall supply of pharmacist human resources18. To address regional disparities in the distribution of pharmacists, the government should establish cross-regional mobility mechanisms. These mechanisms may include special subsidies and optimized talent introduction policies to facilitate the redistribution of surplus pharmacist resources from the eastern region to the central and western regions. Additionally, increased health funding and policy support should be provided to the central and western regions to create opportunities for new pharmacy graduates and attract talent.[48] Finally, to address hierarchical disparities, efforts should focus on supporting the development of primary health care institutions. This includes optimizing resource allocation systems, prioritizing the basic needs of primary health care institutions in terms of the number of pharmacists, hardware facilities, pharmacy service capacity, and providing special salary subsidies to pharmacists working at the grassroots level.

Limitations

Due to data limitations, this study focuses on the period from 2012 to 2022. While this timeframe effectively captures trends in the allocation of pharmacist human resources during this period, it may not fully reflect the current situation. Rapid changes in China's healthcare policies, economic development, and demographic structure could have significantly altered the resource allocation landscape. For instance, certain regions may now be experiencing either a surplus or shortage of pharmacists. In particular, the eastern region may face an oversupply of pharmacists—a development not accounted for in this study.

Conclusion

This study found that the overall number of pharmacists in China continues to grow, but there are still significant differences in resource allocation. First, there are large differences in the allocation of different healthcare organizations, with the number of pharmacists in hospitals almost twice as many as in primary healthcare organizations, and this gap is particularly prominent in the central region. Secondly, there are significant regional differences, with the eastern region having a significant leading edge in resources and the central and western regions in a state of catching up, but the number of pharmacists in the west is still insufficient. Further analysis reveals that regional differences show different trends, with the regional gap in the distribution of hospital pharmacists gradually narrowing, but the gap in primary healthcare institutions intensifying, the internal imbalance in the east worsening, and the gap in the central and western regions widening due to the impact of epidemics. Spatial β-convergence indicated that there was a trend of convergence in pharmacist allocation across regions in China, but the rate of convergence was significantly higher in hospital tiers than in PHCs. These results suggest that pharmacist resource allocation is still facing both structural and regional challenges. This study goes beyond previous studies by revealing the dynamic changes in resource distribution and the impact of epidemics on regional disparities in terms of hierarchical and dynamic dimensions, emphasizing the lag and structural imbalance in resource adjustment in primary institutions. The findings have important implications for China's health policy making, especially in terms of improving the equity of healthcare resources, optimizing the allocation of primary pharmacists and reducing regional disparities. Future workforce planning needs to further study the long-term trends in resource distribution and the effects of policy interventions on different tiers of the healthcare system, as well as strengthen support for central, western, and grassroots institutions, in order to promote a more balanced allocation of resources and to provide a guarantee for the achievement of the goal of universal healthcare.

Abbreviation

PHC, Primary healthcare institutions.

Data Sharing Statement

If someone wishes to access the original data, they should contact the corresponding author.

Funding

This work is supported by Hefei Maternal and Child Health Hospital hospital-level scientific research projects (yb2023_2_9), The second batch of key research projects on medical and health system reform by the Chinese Society of Health Economics, "Research on the Current Status of Coordination of the 'Three Medical' Policies and Guarantee Mechanisms" (CHEATGZZ20250203), Hefei Social Science Planning Project (HFSKYY202559), Research Project for Universities in Anhui Province (2023AH050717) Quality Project for Graduate Students in Anhui Province (RC2400000774) and Quality Project for Cultivating People in the New Era of the Education Department of Anhui

Province (2023cxcys116). The funders had no involvement in study design, data collection, statistical analysis and manuscript writing.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Organization WH. *Global Strategy on Human Resources for Health: Workforce 2030*. Geneva: World Health Organization; 2016.
2. Ling H, Huiqing M, Xiaojie S, et al. Construction of a data mining model for signaling serious adverse drug reactions based on real-world data--an empirical example of bilewood preparations. *China Food Drug Admin Magazine*. 2024;(10):102–111. doi:10.3969/j.issn.1673-5390.2024.10.012
3. Aitken M, Gorokhovich L. Advancing the responsible use of medicines: applying levers for change. *SSRN Electron J*. 2013.
4. Chen W, Yuqi F, Lulu S, Xi C, Hongmei L, Yingbo Z. Reflections on pharmacy professional and technical staffing in medical institutions in China. *Chin Health Quality Manage*. 2024;31(04):7–10+20. doi:10.13912/j.cnki.chqm.2024.31.4.02
5. Jiaqi W, Qiuchan Z, Yang ZG, Liu Y, Lili S. Analysis of the service capacity of primary healthcare institutions in Guangzhou. *China Rural Health*. 2023;15(10):16–19. doi:10.20126/j.cnki.1674-361X.2306-016
6. Park HR, Park SQ, Kim JH, Hwang JC, Lee GS, Chang JC. Geographic analysis of neurosurgery workforce in Korea. *J Korean Neurosurg Soc*. 2018;61(1):105–113. doi:10.3340/jkns.2017.0303.006
7. Silva M, de Almeida ATC, de Arauujo IT. Equity analysis of resource distribution for the popular pharmacy program. *Revista de Saude Publica*. 2019;5350. doi:10.11606/S1518-8787.2019053000731
8. Mollahaliloglu S, Yardim M, Telatar TG, Uner S. Change in the geographic distribution of human resources for health in Turkey, 2002–2016. *Rural Remote Health*. 2021;21(2):6478. doi:10.22605/RRH6478
9. Ismail M. Regional disparities in the distribution of Sudan's health resources. *East Mediterr Health J*. 2020;26(9):1105–1114. doi:10.26719/emhj.20.056
10. Wang Z, He HY, Liu X, Wei HK, Feng QM, Wei B. Health resource allocation in Western China from 2014 to 2018. *Arch Public Health*. 2023;81(1):30. doi:10.1186/s13690-023-01046-x
11. Zhou MH. Equity and efficiency of health resource allocation in Sichuan Province, China. *BMC Health Serv Res*. 2024;24(1):1439. doi:10.1186/s12913-024-11946-5
12. Chen BQ, Jin FL. Spatial distribution, regional differences, and dynamic evolution of the medical and health services supply in China. *Front Public Health*. 2022;101020402. doi:10.3389/fpubh.2022.1020402
13. Liu T, Li JX, Chen J, Yang SL. Regional differences and influencing factors of allocation efficiency of rural public health resources in China. *Healthcare*. 2020;8(3):270. doi:10.3390/healthcare8030270
14. Gong YH, Ma D, Feng W. Study on the allocation efficiency of medical and health resources in Hainan Province: based on the super-efficiency SBM-Malmquist model. *PLoS One*. 2024;19(2):e0294774. doi:10.1371/journal.pone.0294774
15. Ni HF, Yuan M, Wan P, et al. The allocation and fairness of hospital pharmacist human resources in China: a time-series study. *BMC Health Serv Res*. 2024;24(1):1370. doi:10.1186/s12913-024-11882-4
16. Guo W, Zhang H, Lin YQ, et al. Analysis of relevant factors influencing the development of pharmacist human resources in China: based on the time series vector auto-regression model. *Risk Manage Healthcare Policy*. 2025;18:505–515. doi:10.2147/RMHP.S484621
17. Ning W, Guangpeng Z, Tiemin Z, Yuan D. Construction and optimization of a pharmacist demand measurement model for healthcare organizations. *Chinese Health Econ*. 2019;38(05):51–55. doi:10.7664/CHE20190513
18. Mingyue Z, Jiaming Z, Xuan L, Shijin Z. Research on the current situation and equity of pharmacist allocation in China's healthcare institutions based on agglomeration degree. *Chin Hospital Manage*. 2024;44(06):56–60.
19. Ruochen Q, Qianggang B. Spatial distribution and dynamic changes of pharmacist resources in China. *China Pharm*. 2022;33(15):1898–1900+1910. doi:10.6039/j.issn.1001-0408.2022.15.20
20. Bin Z, Ying M, Ning Z, et al. Research on the allocation and optimization strategy of pharmacists and technicians in China based on spatial analysis. *Chinese Health Service Manage*. 2022;39(07):520–526.
21. YongZhi H. Study on the allocation status and fairness of hospital pharmacists in Tianjin after the new medical reform. *China Pharm*. 2014;25(13):1159–1161. doi:10.6039/j.issn.1001-0408.2014.13.03
22. Jie Z, Xiaona L. Measurement and decomposition of household income inequality of herders in Inner Mongolia-based on Dagum's gini coefficient approach. *J Inner Mongolia Agri Univ*. 2024;26(06):1–10. doi:10.16853/j.issn.1009-4458.2024.06.001
23. Shen YQ, Sun ZS. Estimating the spatial correlation and convergence of China's healthcare resources allocation: evidence from the Yangtze River Delta Region. *Arch Public Health*. 2022;80(1):207. doi:10.1186/s13690-022-00958-4
24. Zha QF, Liu Z, Song ZH, Wang J. A study on dynamic evolution, regional differences and convergence of high-quality economic development in urban agglomerations: a case study of three major urban agglomerations in the Yangtze river economic belt. *Front Environ Sci*. 2022;101012304. doi:10.3389/fenvs.2022.1012304
25. Dagum C. A new approach to the decomposition of the Gini income inequality ratio. *Empirical Econ*. 1997;22(4):515–531. doi:10.1007/BF01205777
26. Li S, Wenxiao F. Spatial differences and distributional dynamic evolution of science and technology financial efficiency in China. *Manage Rev*. 2021;33(01):44–53+67. doi:10.14120/j.cnki.cn11-5057/f.2021.01.003
27. de Campos AC, Lopes L, Carreira C. Spatial autocorrelation of exports and R&D expenditures in Portugal. *J Knowledge Econ*. 2024;15(2):8632–8653. doi:10.1007/s13132-023-01425-3
28. Sun J, Fan P, Wang K, Yu Z. Research on the impact of the industrial cluster effect on the profits of new energy enterprises in China: based on the Moran's I index and the fixed-effect panel Stochastic frontier model. *Sustainability*. 2022;14(21). doi:10.3390/su142114499

29. Chen MH, Zhang TW, Chu QR, et al. Convergence analysis of inclusive green growth in China based on the spatial correlation network. *Sustainability*. 2023;15(16):12344. doi:10.3390/su151612344
30. Castellanos-Sosa FA, Cabral R, André Varella M. Energy reform and energy consumption convergence in Mexico: A spatial approach. *Structural Change and Economic Dynamics*. 2022;61:336–350. Available from: https://doi.org/10.1016/j.strueco.2022.03.007
31. Cavalieri M, Ferrante L. Convergence, decentralization and spatial effects: an analysis of Italian regional health outcomes. *Health Policy*. 2020;124 (2):164–173. doi:10.1016/j.healthpol.2019.12.001
32. Tang H, Ao RJ, Li YL. The spatio-temporal pattern and its influencing factors of production efficiency of health resources in China. *Front Public Health*. 2024;121376518. doi:10.3389/fpubh.2024.1376518
33. Zhou Y, Zhao KX, Han JL, Zhao SD, Cao JY. Geographical pattern evolution of health resources in China: spatio-temporal dynamics and spatial mismatch. *Trop Med Infect Dis*. 2022;7(10):292. doi:10.3390/tropicalmed7100292
34. Yu YY, Lu JC, Dou XF, Yi YH, Zhou L. Spatial distribution and influencing factors of CDC health resources in China: a study based on panel data from 2016–2021. *Front Public Health*. 2024;121331522. doi:10.3389/fpubh.2024.1331522
35. Elhorst JP. Specification and estimation of spatial panel data models. *Int Regional Sci Rev*. 2003;26(3):244–268. doi:10.1177/0160017603253791
36. Xinghuan W, Lili C, Xinglong Z, Jun F. Evaluation of the fairness of health resource allocation in Guangxi's specialized public health institutions based on HRAD-GIS method and its spatial difference analysis. *Chin J Health Statis*. 2024;41(05):742–746. doi:10.11783/j.issn.1002-3674.2024.05.023
37. Shizhong T, Mengmeng T, Xiaoyue L. Fiscal expenditure, government competition and health care service levels - an empirical analysis based on provincial panel entropy Tobit models. *J Yunnan Univ Finance Econom*. 2022;38(08):19–36. doi:10.16537/j.cnki.jynufe.000807
38. Yueran Y, Fei L. Research on the coupled and coordinated relationship between the degree of health technician agglomeration and the level of urbanization in China. *Med Soc*. 2024;37(06):59–65. doi:10.13723/j.yxysh.2024.06.009
39. Ruizhi P, Qiannan L. Expensive medical treatment and government expenditure in the context of healthy China: an analysis based on the perspective of structural imbalance of resource allocation. *J Xi'an Jiaotong Univ*. 2024;44(02):104–116. doi:10.15896/j.xjtuskxb.202402010
40. Yongyi G, Jing Z, Yunhan S, Yaru L, Xinran W, Xinyu L. Research on the equity of human resource allocation and its driving path in Chinese traditional medicine in China--an analysis based on fsQCA methodology. *Chin J Health Policy*. 2024;17(10):46–51. doi:10.3969/j.issn.1674.2982.2024.10.007
41. Chai YL, Xian GW, Kou RX, et al. Equity and trends in the allocation of health human resources in China from 2012 to 2021. *Arch Public Health*. 2024;82(1):175. doi:10.1186/s13690-024-01407-0
42. Ao YB, Feng QQ, Zhou ZL, Chen YF, Wang T. Resource allocation equity in the China's rural three-tier healthcare system. *Int J Environ Res Public Health*. 2022;19(11):6589. doi:10.3390/ijerph19116589
43. Kai H, Weifang Y. Survey and analysis of human resources of Chinese pharmacists in Ningbo medical institutions. *J Trad Chin Med Manag*. 2025;33(1). doi:10.16690/j.cnki.1007-9203.2025.01.016
44. Zhiyong D, Chenxiao Z. Ten years of "New Medical Reform": achievements, dilemmas and path choices of China's medical and health care development. *Reform*. 2020;(09):149–159.
45. Di L, Yumei H. A study on the allocation and equity of health manpower resources in Beijing municipality. *Hospital Manage Forum*. 2024;41 (11):15–18.
46. Weiwei W. New quality productivity, urban-rural income gap and shared prosperity. *J Tech Econom Manage*. 2025;(02):52–57.
47. Lina Y, Wei Z, Yaoyao J, Baiyue A, Yajuan L. Analysis of the current situation of talent aggregation and development strategies in public hospitals. *Chin Hospital Manage*. 2025;45(01):29–32.
48. Yu S, Shuang W, Li Q. A study of regional differences and dynamic evolution of the equity of general practitioner allocation in China. *Health Econom Res*. 2024;41(09):16–20. doi:10.14055/j.cnki.33-1056/f.2024.09.003

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