A Study on the Equity of Human Resource Allocation for Geriatric General Practitioners in China in the Context of Population Aging (Postprint)

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Abstract

Background China entered an aging society in 1999, characterized by rapid growth, a large base, and the feature of "getting old before getting rich." The intensifying aging population poses challenges to the pension system, making the implementation of elderly health management a scientific coping strategy. As gatekeepers of primary healthcare, general practitioners play a core role in conducting elderly health management and implementing the "Big Health" concept, serving as the main force in addressing the challenges of population aging.

Objective To investigate the regional distribution dynamics and equity differences in the allocation of human resources for elderly general practitioners in China from 2012 to 2021, and to analyze the factors influencing the level of human resource allocation, thereby providing references for the government to formulate scientific policies regarding elderly human resource allocation.

Methods This study collected relevant data from the 2013–2022 China Statistical Yearbook and China Health Statistics Yearbook, calculated the trends in the Gini coefficient and Theil index for general practitioners based on both total population and elderly population distributions to evaluate the equity of human resource allocation for elderly general practitioners, and constructed a two-way fixed-effects panel model for the allocation level of general practice human resources across provinces.

Results Between 2012 and 2021, the total number of general practitioners increased by 325,074, with all provinces achieving varying degrees of growth. The number of general practitioners per 10,000 elderly population reached 21.66, and the Gini coefficient decreased from 0.38 to 0.33. The total Theil index, as

well as the between-group and within-group Theil indices, all declined. Analysis results from the two-way fixed-effects panel model showed that among health resources, the number of nurses had a significant negative effect, while the number of hospital beds and practicing physicians had significant positive effects; total population and aging rate were positively associated; road density negatively affected resource allocation; whereas economic development level, education indicators, and outpatient service volume did not show significant effects.

Conclusion From 2012 to 2021, the allocation level of human resources for elderly general practitioners in China continued to develop, with equity continuously improving. Based on this trend, the government should comprehensively consider multiple factors, including the aging rate, when planning the allocation of general practitioner human resources to achieve more scientific and rational resource allocation.

Full Text

Research on the Fairness of Human Resource Allocation of Geriatric General Practitioners in China under the Background of Population Aging

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Abstract

Background: China entered an aging society in 1999, characterized by rapid growth rate, large population base, and the distinctive pattern of "aging before affluence." The intensifying aging trend poses significant challenges to the pension system, making the implementation of elderly health management a scientifically sound response strategy. As gatekeepers of primary healthcare, general practitioners play a pivotal role in advancing elderly health management and implementing the "comprehensive health management" philosophy, serving as the primary force in addressing aging-related challenges.

Objective: This study investigates the dynamic geographical distribution and equity disparities in the allocation of geriatric general practitioner human resources across China from 2012 to 2021, while analyzing the influencing factors of human resource allocation levels. The findings aim to provide evidence-based references for policymakers to formulate scientific human resource allocation strategies for elderly healthcare services.

Methods: This study collected relevant data from the *China Statistical Yearbook* and *China Health Statistics Yearbook* spanning 2013 to 2022. By calculating the changing trends of Gini coefficients and Theil indices based on the total and elderly population distributions, we assessed the equity in human resource allocation of geriatric general practitioners. Furthermore, a two-way fixed effects panel model was constructed to examine the province-level allocation of general practice human resources across various regions.

Results: During the period from 2012 to 2021, the total number of general practitioners in China increased by 325,074, with all provinces demonstrating varying degrees of growth in their general practitioner workforce. The number of general practitioners per 10,000 elderly population reached 21.66, while the Gini coefficient decreased from 0.38 to 0.33. Both the overall Theil index and its inter-group and intra-group components exhibited declining trends. The results of the panel two-way fixed effects model analysis revealed that among healthcare resources: the number of nurses exerted a significant negative effect, whereas bed capacity and licensed physicians demonstrated significant positive effects on resource allocation. Population size and aging rate showed positive associations with resource distribution. Road density exhibited a negative impact on resource allocation. However, economic development level, educational indicators, and outpatient service volume did not exhibit statistically significant effects.

Conclusion: From 2012 to 2021, China witnessed sustained development in the allocation of human resources for geriatric general practitioners, accompanied by progressive improvements in equity. Given this trend, policymakers should holistically consider multiple factors—including population aging rates—when formulating workforce allocation strategies for general practitioners, to achieve more scientifically grounded and rational resource distribution.

Keywords: Healthy Aging; Population ageing; Allocation of health resources; Elderly population; General practitioners; Fairness

1. Data Sources and Methods

Population aging represents an inevitable challenge in the development of human society. China entered an aging society in 1999, characterized by rapid aging speed, a large elderly population base, and the distinctive pattern of "aging before affluence" [1]. The seventh national census bulletin revealed that in 2020, China' s population aged 60 and above reached 264 million, accounting for 18.7% of the total population, while those aged 65 and above numbered 191 million, representing 13.5% of the total population [2]. The deepening aging trend poses enormous challenges to various aspects of Chinese society, particularly the pension system [3]. Implementing health management strategies targeted at the elderly population represents a low-cost, scientifically effective approach to addressing population aging [4]. As gatekeepers of primary healthcare, general practitioners constitute a critical link in achieving universal health under

the "comprehensive health" philosophy and serve as the main force in delivering health management services to the elderly [5].

Optimizing the allocation of general practitioner human resources to ensure fairness and rationality is essential for improving the quality of health management for the elderly and achieving health equity. Simultaneously, this serves as an objective indicator of a country or region's commitment to elderly health 事业 development [6]. Previous scholars have employed Theil index, Lorenz curve, Gini coefficient, and agglomeration degree methods to investigate the equity of general practitioner resource allocation across China, Shandong Province, Guangxi Zhuang Autonomous Region, and the Guangdong-Hong Kong-Macao Greater Bay Area [7-10], yielding important findings. However, research on factors influencing allocation equity remains relatively scarce, with most studies focusing on the total number of general practitioners and allocation across the entire population [7-10], while paying limited attention to the elderly demographic. Against the backdrop of population aging, this study examines the allocation level and equity of geriatric general practitioner human resources and analyzes the factors influencing human resource allocation levels, providing reference for government policy formulation.

1.1 Data Sources

Data were extracted from the *China Statistical Yearbook* and *China Health Statistics Yearbook* for the period 2013-2022. From the *China Statistical Yearbook*, we obtained data on "tertiary industry GDP proportion," "geographical area," "urbanization rate," "highway mileage," "per capita GDP," "undergraduate and college graduates," "total population," and "elderly population." From the *China Health Statistics Yearbook*, we collected data on "number of general practitioners," "licensed (assistant) physicians," "registered nurses," "medical institution beds," "medical institution outpatient service volume," "average hospital stay," and "hospital bed utilization rate." Following the classification standards of the *China Health Statistics Yearbook*, China's 31 provinces (excluding Hong Kong, Macao, and Taiwan) were divided into eastern, central, and western regions, comprising 11, 8, and 12 provinces respectively.

1.2 Research Methods

1.2.1 Descriptive Analysis This study analyzed the overall allocation of general practitioners across provinces from 2012 to 2021 and compared regional differences. The geriatric general practitioner human resources examined in this study specifically refer to the number of doctors registered as general medicine specialists and those who have obtained general practitioner training certificates available to the elderly population (aged 65 and above) in each province (collectively referred to as "general practitioners"). To more accurately reflect the demand for general practitioners among the elderly population across regions, this study constructed an elderly population-adjusted indicator: the number of general practitioners per 10,000 elderly population. Similar to metrics such as

"general practitioners per 10,000 population" or "nurses per 1,000 elderly population," this adjusted figure reflects the relative allocation level of human resources and enables annual and regional comparisons [11], as shown in Equation (1).

$$\text{General Practitioners per 10,000 Elderly Population} = \left(\frac{\text{Number of General Practitioners}}{\text{Elderly Population}}\right) \times 10,000 \quad (1)$$

1.2.2 Equity Analysis To thoroughly investigate the equity of general practitioner resource allocation across Chinese regions from 2012 to 2021, this study employed the Gini coefficient and Theil index for comprehensive evaluation. The Gini coefficient, a commonly used metric for measuring resource allocation equity, ranges between 0 and 1. A Gini coefficient below 0.3 indicates excellent equity, 0.4 represents a warning threshold, and exceeding 0.6 signals high inequity [12]. The Theil index further reveals resource allocation inequality, with smaller values indicating better equity. The Gini coefficient formula is presented in Equation (2), and Theil index formulas in Equations (3)-(6).

$$\text{Gini} = \sum P_i Y_i + 2 \sum P_i (1 - V_i) - 1 \quad (2)$$

$$\text{Theil} = \sum P_i \log\left(\frac{P_i}{Y_i}\right) \quad (3)$$

$$\text{Theil} = \text{Theil}_{\text{within}} + \text{Theil}_{\text{between}} \quad (4)$$

$$\text{Theil}_{\text{within}} = \sum P_g T_g \quad (5)$$

$$\text{Theil}_{\text{between}} = \sum P_g \log\left(\frac{P_g}{Y_g}\right) \quad (6)$$

Where P_i represents the population proportion of each province, Y_i represents the proportion of general practitioners in each province, and V_i is the cumulative value of Y_i. Inter-group differences refer to allocation disparities among the eastern, central, and western regions, while intra-group differences refer to disparities within each region.

1.3 Statistical Methods

This study used EpiData 3.0 software to establish the database with double-entry verification and Stata 13.0 for statistical analysis. A multi-factor regression analysis was conducted to construct a two-way fixed effects panel model

for provincial general practice human resource allocation levels. The model is specified as follows:

$$Y_{it} = \beta_0 + X_{it}\beta + Z_{it}\delta + \gamma_t + \mu_i + \varepsilon_{it} \quad (7)$$

Where Y_{it} represents the number of general practitioners in province i at time t, X_{it} denotes independent variables, Z_{it} represents control variables, γ_t is the year fixed effect, μ_i is the time-invariant individual fixed effect, and ε_{it} is the random disturbance term.

2. Results

From 2012 to 2021, the total number of general practitioners in China increased by 325,074. In absolute terms, Jiangsu, Guangdong, Shandong, Henan, and Hebei provinces showed the largest increases, growing by 34,365, 31,076, 29,139, 29,108, and 20,917 practitioners respectively. The smallest increases occurred in Tibet (433), Beijing (1,166), Qinghai (1,224), Ningxia (1,367), and Hainan (2,432). In terms of average annual growth rate, the national average was 14.01%, though substantial variation existed across provinces. Tibet achieved the highest average annual growth rate at 33.79%, while Beijing recorded the lowest at just 1.50%. Nineteen provinces exceeded the national average growth rate, including six in the eastern region, five in the central region, and eight in the western region .

Regarding regional growth, compared with 2012, the eastern region added the most general practitioners in 2021 (157,828), followed by the central region (91,565) and the western region (75,681). In percentage terms, the eastern region' s share decreased by 8.92%, while the central and western regions' shares increased by 5.95% and 2.97% respectively .

2.2 Geographic Distribution and Trends of Geriatric General Practitioner Resources

In 2012, the number of general practitioners per 10,000 elderly population was 12.78 in the eastern region, 5.51 in the central region, and 6.06 in the western region. By 2021, these figures had risen to 25.99, 18.30, and 18.50 respectively. The average annual growth rates for the eastern, central, and western regions were 5.80%, 4.94%, and 4.58%, showing clear upward trends with minimal regional variation. Throughout the decade, the eastern region consistently exceeded the national average, while the central and western regions remained below it [Figure 1: see original paper] .

2.3 Equity Analysis

2.3.1 Gini Coefficient Trends Between 2012 and 2021, the Gini coefficient for general practitioner distribution remained between 0.30 and 0.38 when sorted

by total population, indicating overall stability. The Gini coefficient sorted by elderly population decreased from 0.38 in 2012 to 0.33 in 2021 [Figure 2: see original paper].

2.3.2 Theil Index Results From 2012 to 2021, the Theil index decreased from 0.078 to 0.016, indicating improved overall equity in general practitioner allocation. Decomposition results showed that intra-group differences declined from 0.044 to 0.010, while inter-group differences fell from 0.034 to 0.006, suggesting enhanced equity both within and between regions .

2.4 Panel Two-Way Fixed Effects Model Results

To identify factors influencing provincial general practitioner resource allocation, this study established a two-way fixed effects panel model incorporating time and province dimensions. Using the number of general practitioners as the dependent variable, the model examined impacts of healthcare resources, economic development, education, population, bed utilization, and health service accessibility. Results showed that among healthcare resources, nurses per 1,000 population negatively correlated with general practitioner numbers ($P<0.001$), while beds per 1,000 population ($P=0.008$) and licensed (assistant) physicians per 1,000 population ($P=0.002$) showed significant positive effects. Economic indicators including per capita GDP, tertiary industry proportion, and urbanization rate were not significant ($P>0.05$). Educational level, measured by undergraduate and college graduates per 1,000 population, also showed no significant effect. Population factors—total population and aging rate—positively promoted general practitioner numbers ($P<0.001$), while outpatient service volume per 1,000 population was not significant. Regarding health service accessibility, road density negatively correlated with general practitioner numbers ($P=0.045$) .

3. Discussion

3.1 Increasing Yet Insufficient Geriatric General Practitioner Resources

In 2015, the WHO introduced the concept of "healthy aging" from a life-course and functional perspective, emphasizing the development and maintenance of functional capacity to ensure well-being in older age [13]. This shift refocused attention on the elderly from traditional care and medical services toward disease prevention and health management [14]. General practitioners and general practice teams serve as critical links in primary health management and as "gatekeepers" for elderly health, safeguarding health outcomes for older populations [15].

From 2012 to 2021, China added 325,074 general practitioners, achieving an average annual growth rate of 16.53%. By the end of 2021, general practitioners reached 3.08 per 10,000 population, meeting the State Council' s target of

2-3 general practitioners per 10,000 urban and rural residents by 2020. The number of general practitioners per 10,000 elderly population reached 21.66, though this remains distant from the 2030 requirement of 5 general practitioners per 10,000 residents [16]. To address this shortage, the General Office of the CPC Central Committee and the State Council issued "Opinions on Further Improving the Medical and Health Service System" in March 2023, calling for strengthened standardized residency training in general practice, expansion of the general practitioner workforce, and provision of comprehensive, continuous health management services for the elderly [17].

3.2 Improved Equity in Geriatric General Practitioner Distribution

Our findings show that intra-group differences decreased from 0.044 to 0.010 and inter-group differences from 0.034 to 0.006, reflecting improved equity in geriatric general practitioner distribution both within and between regions. This improvement likely stems from the establishment of comprehensive and efficient primary healthcare systems in all provinces under the guidance of policies such as "Opinions on Deepening Medical and Health System Reform" [18] and the "Healthy China 2030" Planning Outline [19]. These policies have attracted increasing numbers of medical students to join the general practice workforce and contribute to elderly health management services, objectively promoting balanced distribution across regions and advancing elderly health 事业 development.

However, results indicate that central and western regions still lag behind the eastern region in geriatric general practitioner resources. To achieve sustained optimization of resource distribution, greater investment and policy support should be directed toward resource-scarce regions, promoting the continuous flow of health management services and general practitioner resources to relatively underdeveloped areas [20].

3.3 Multiple Factors Should Inform Resource Allocation

This study employed a two-way fixed effects panel model incorporating time and province dimensions to explore factors influencing general practitioner resource allocation. Results indicate that licensed (assistant) physicians per 1,000 population, beds per 1,000 population, total population, and aging rate positively promote general practitioner numbers, while nurses per 1,000 population and road density exhibit negative effects. This may reflect long-standing issues of low professional status and compensation for general practitioners in mainland China, affecting work motivation and exacerbating brain drain [10]. Conversely, nursing has relatively lower entry barriers and a younger workforce structure [11], attracting increasing numbers of young people under challenging employment conditions, contrasting with the situation for general practitioners. Additionally, provinces with high health service accessibility are predominantly located in the eastern region, which boasts strong economic power but smaller geographical areas compared to central and western regions [21]. Consequently,

these provinces have lower absolute numbers of general practitioners than regions with poorer health service accessibility and relatively backward economic development, consistent with Guan Hongcai et al.' s findings on elderly nursing human resource equity [11].

To ensure equal access to health management services for the elderly, policymakers must comprehensively consider multiple factors including healthcare resources, economic development, education, population, bed utilization, and health service accessibility. Future efforts should intensify general practitioner training and recruitment in central and western regions to promote balanced national allocation of geriatric general practitioner resources.

Author Contributions

LIANG Zhenning proposed the research objectives, designed the study, implemented the research, collected and organized data, and wrote the manuscript. ZHOU Qingping and LIU Hanyue performed statistical analysis and created figures and tables. ZHAN Shengfan and YU Yao revised the manuscript. QIAN Yi was responsible for quality control and review, overall article supervision, and project management.

Conflicts of Interest: None declared.

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Note: Figure translations are in progress. See original paper for figures.