ChinaRxiv

AI translation · View original & related papers at
chinarxiv.org/items/chinaxiv-202503.00208

Equity Analysis of General Practitioner Allocation and Demand Forecasting in Xinjiang: Postprint

Authors: Chen Dongran, Xu Peilan, Ding Lei, Li Yuhua, Li Yuhua

Date: 2025-03-19T00:00:00+00:00

Abstract

Background: As gatekeepers of residents'health, general practitioners (GPs) constitute the main force of primary healthcare services in China. Xinjiang faces prominent issues such as shortages of primary-level human resources and irrational talent structures that need to be urgently addressed. Objective: Based on understanding the current allocation status of GPs in Xinjiang, to evaluate the equity of allocation and forecast the demand and shortage numbers of GPs in Xinjiang Uygur Autonomous Region from 2025 to 2030, providing a reference basis for rational allocation and training of GPs across the region. Methods: Agglomeration degree, Lorenz curve, and Gini coefficient were applied to analyze the equity of GP allocation, combined with the average growth model and health demand forecasting method to predict the demand and shortage numbers of GPs. Results: The average annual growth rate of GPs in Xinjiang was 16.58%. It is forecasted that approximately 9,411–9,452 GPs will be needed by 2025, with a shortage of 3,938–3,979. The agglomeration degree of GP resources allocated by population was all greater than 0, while that allocated by geographical area was all less than 1, and both showed a declining trend year by year. The Gini coefficients of training quota numbers allocated by population were all less than 0.3 for various regions and overall. The overall Gini coefficient and that of northern Xinjiang allocated by geographical area were 0.415 and 0.457 respectively, while other regions' Gini coefficients were all less than 0.3. Conclusion: The allocation and training of GPs in Xinjiang have made certain progress with a relatively fast growth rate, and the quantity has reached the overall target. However, a large shortage remains. The equity of GP resources allocated by population is better than that by geographical area, with northern Xinjiang being the main source of inequity in training quota allocation by geographical area. Therefore, in further GP allocation and training efforts, on the basis of referencing the predicted demand and shortage numbers, the GP workforce should continue to be expanded, taking key regions as the entry point to

continuously improve the equity of allocation by geographical area, while ensuring the quantity of GPs and taking into account the accessibility of healthcare services.

Full Text

Equity Analysis and Demand Forecast of General Practitioner Allocation in Xinjiang

CHEN Dongran[12], XU Peilan[3], DING Lei[4], LI Yuhua[1]*

[1]School of Public Health, Xinjiang Medical University, Urumqi 830000, China
[2]The First Affiliated Hospital of Jinzhou Medical University, Jinzhou 121000, China
[3]Xinjiang Second Medical College, Karamay 834000, China
[4]Research and Education Department, Health Commission of Xinjiang Uygur Autonomous Region, Urumqi 830000, China

Corresponding author: LI Yuhua, Researcher; E-mail: 308444163@qq.com

Abstract

Background: General practitioners (GPs), as the gatekeepers of residents' health, constitute the main force in China' s primary healthcare system. Xinjiang faces urgent challenges including severe shortages and structural imbalances in grassroots health human resources. **Objective:** This study evaluates the equity of GP allocation in Xinjiang and forecasts demand and shortfall numbers for 2025–2030, providing evidence-based recommendations for rational GP allocation and training. **Methods:** We analyzed allocation equity using health resource agglomeration degree (HRAD), Lorenz curves, and Gini coefficients, combined with an average growth model and health demand forecasting method to project GP demand and gaps. **Results:** The average annual growth rate of GPs in Xinjiang was 16.58%. Forecasts indicate that approximately 9,411–9,452 GPs will be needed by 2025, with a projected shortfall of 3,938–3,979. HRAD values were greater than 0 for population-based allocation but less than 1 for geographic area-based allocation, with both metrics declining annually. Gini coefficients for training quota allocation by population were below 0.3 across all regions, while those for geographic allocation exceeded 0.4 for both the entire region (0.415) and northern Xinjiang (0.457). **Conclusion:** GP allocation and training in Xinjiang have progressed significantly with rapid growth, achieving overall quantity targets, yet substantial gaps remain. Population-based allocation demonstrates better equity than geographic-based allocation, with northern Xinjiang representing the primary source of inequity in geographic allocation of training quotas. Future efforts should expand the GP workforce based on projected demand and gaps, prioritize key regions to improve geographic allocation equity, and balance workforce quantity with healthcare accessibility.

Keywords: General practice; General practitioner; Resource allocation; Equity; Xinjiang

Introduction

The *14th Five-Year Plan for Health Standardization* emphasizes strengthening standardized construction of primary healthcare institutions to improve service standardization and enhance integrated prevention-treatment and health management capabilities. As gatekeepers of residents' health, GPs serve as primary providers and implementers of grassroots medical services, representing critical health human resources whose allocation directly affects equitable access to essential healthcare. The *Xinjiang Uygur Autonomous Region Health Development 14th Five-Year Plan* identifies persistent challenges in grassroots talent shortages and structural imbalances. While existing research has examined GP allocation nationally and in select provinces, Xinjiang lacks such comprehensive analysis. This study evaluates current GP allocation status, assesses equity using agglomeration degree, Gini coefficient, and Lorenz curves, and forecasts demand and shortfall numbers for 2025–2030 to inform rational GP allocation and training policies in Xinjiang.

Methods

Data Sources Population and geographic area data were obtained from the *China Statistical Yearbook* (2021). GP statistics, including total numbers, those registered in general practice, and certified training completers, were sourced from the *China Health Statistics Yearbook* (2013–2020) and Xinjiang Health Commission training quota allocation documents. The dataset encompassed: (1) Xinjiang GP totals, general practice registrations, certified training completers, and GPs per 10,000 population from 2012–2019; (2) GP training quota allocations across Xinjiang prefectures from 2010–2019; and (3) Xinjiang population numbers and geographic areas.

Analytical Methods Data were processed and analyzed using Excel software. We employed logarithmic, sequential, time series, and semi-logarithmic charts to describe GP status and temporal trends. Equity analysis utilized agglomeration degree, Lorenz curves, and Gini coefficients.

Agglomeration Degree: We applied HRAD to evaluate population- and geography-based allocation equity for total GPs, registered general practice physicians, and certified training completers. HRAD represents the ratio of health resources in a region to the proportion of national geographic area (1%), where HRAD=1 indicates absolute equity, >1 suggests favorable equity, and <1 indicates poor equity. Population agglomeration degree (PAD) represents the ratio of regional population to 1% of national geographic area; HRAD minus PAD reveals population-based allocation equity, where values >0 indicate

resource surplus and <0 indicate shortage.

Lorenz Curve and Gini Coefficient: We plotted Lorenz curves and calculated Gini coefficients to quantitatively analyze training quota allocation equity by population and geographic area. Lorenz curves plot cumulative population (or geographic area) percentages against cumulative GP resource percentages, with the diagonal representing perfect equity. Greater curvature indicates higher inequality. Gini coefficients were calculated from these curves, where <0.2 indicates absolute equity, 0.2–0.3 relative equity, 0.3–0.4 reasonable equity, 0.4 a warning threshold, 0.4–0.5 inequity, and $ $0.6 severe inequity.

Average Growth Model and Health Demand Method: The average growth model [$P=P_0(1+k)^n$] estimated Xinjiang' s population, where P_0 is base-year population, k is projected average growth rate (12.97%), and n is forecast period. The health demand method directly estimated required GP numbers based on population, two-week consultation rate, primary care utilization intention, and visit volume.

Results

Basic Status of GPs in Xinjiang From 2012–2019, Xinjiang' s GP workforce increased by 184.3% (annual growth rate: 16.58%). Registered general practice physicians grew by 254% (20.6% annually), while certified training completers increased by 152.5% (14.8% annually). Registered GPs showed the fastest growth, rising from 31.8% of the total GP workforce in 2012 to 37.27% in 2019 (annual average: 34.66%). GPs per 10,000 population increased annually with an average growth rate of 14.6% . Semi-logarithmic plots confirmed these trends [Figure 1: see original paper].

Equity Analysis of GP Allocation **GP Resource Allocation Equity:** HRAD values for geographic allocation were consistently <1 and declined annually from 2012–2019. Population-based HRAD values were >0 for all categories, except registered GPs in 2019 which fell below 0, indicating inequity .

Training Quota Allocation Equity: In 2020, Gini coefficients for training quota allocation were 0.231 (population-based) and 0.415 (geographic-based), demonstrating superior population-based equity. Southern and eastern Xinjiang showed good geographic equity (Gini <0.3), while northern Xinjiang' s geographic Gini coefficient exceeded 0.4, indicating inequity . Lorenz curves [FIGURE:2, FIGURE:3] showed greater curvature for geographic allocation, confirming these findings.

GP Allocation Forecasts Using the average growth model with 2021 baseline data, we projected Xinjiang' s population for 2025–2030 and estimated required GP numbers and shortfalls [TABLE:4, TABLE:5].

Discussion

GP Workforce Growth and Persistent Shortfalls Our findings reveal that Xinjiang's GP workforce expanded by 3,548 personnel from 2012–2019, with a remarkable 16.58% annual growth rate—substantially higher than provinces like Shandong, indicating robust development. By 2019, Xinjiang achieved 2.17 GPs per 10,000 population, exceeding western China averages and meeting the 2020 target of 2 GPs per 10,000 population. Growth was most rapid during 2012–2014, coinciding with policy implementation following the 2009 healthcare reform and 2010 national GP development plan, which established short-term training targets and dual pathways (1–2 year conversion training and standardized residency training). By 2014, Xinjiang reached 1.45 GPs per 10,000 population, meeting initial targets and transitioning to stable development.

Despite this progress, our forecasts indicate a 3,938–3,979 GP shortfall by 2025, requiring at least 1,124 additional registered GPs and 2,814 certified training completers. Achieving these targets would yield 3.414–3.428 GPs per 10,000 population by 2025, approaching the 2030 goal of 3–5 GPs per 10,000 population while improving geographic allocation rationality and meeting service demand. To address these gaps, policymakers should establish evidence-based targets, diversify training methods, and strengthen workforce planning. Sustainable development requires balanced attention to undergraduate medical education, continuing education for 骨干 (backbone) and high-level GPs, and ongoing conversion training to create a multi-tiered workforce. Supply-demand coordination must consider both geographic and population factors while guiding rational service utilization. Differentiated regional policies and increased investment in financial support and infrastructure will enhance professional attractiveness and retention.

Superior Population-Based Allocation Equity Population-based allocation equity consistently outperformed geographic-based allocation, with HRAD values >0 for most indicators, while geographic HRAD values remained <1 and declined annually. This aligns with studies on other health workforce categories in Xinjiang and other provinces. The declining population-based HRAD suggests GP growth lagged behind population-driven demand growth, with relative growth advantages less pronounced compared to western China overall. Registered GP numbers require particular attention through incentive mechanisms and policy guidance to enhance registration willingness.

Geographic allocation inequity poses significant challenges for healthcare accessibility, especially critical in Xinjiang' s vast territory. While national policies have emphasized per-capita GP targets, geographic metrics have been overlooked. Our geographic-based forecasts for 2025–2030 provide reference values for improving allocation equity. Some studies suggest "1–2 qualified GPs per township" as a geographic allocation standard. The Lorenz curve analysis confirms that geographic allocation inequity primarily stems from northern Xinjiang (Gini=0.457), where large prefectures like Ili and Bortala receive disproportion-

ately few quotas relative to their geographic size. Conversely, Urumqi' s smaller area but higher quota allocation reflects its status as the capital with more medical institutions and better-developed primary care systems. Southern Xinjiang demonstrates good equity in both population- and geographic-based allocation, attributable to policy prioritization by the Health Commission.

Optimization of Training Quota Allocation Training quota allocation requires optimization, as geographic allocation shows greater Lorenz curve curvature (Gini>0.4) compared to population allocation. Regional analysis reveals that all areas except northern Xinjiang achieve Gini coefficients <0.3 for both metrics. Northern Xinjiang' s geographic allocation Gini of 0.457 represents the primary inequity source, warranting targeted attention. Since training quotas exceed actual certified completers, selection processes should include competency screening to ensure training quality and resource efficiency, thereby accelerating workforce development.

Conclusion

After a decade of GP development, Xinjiang has achieved substantial progress toward training targets, yet significant shortfalls persist. Future efforts must be demand-driven, expanding the GP workforce while prioritizing geographic allocation equity to enhance primary care accessibility. Data limitations prevented subregional analysis of registered GP equity, representing an area for future research. Enhanced forecasting models will further improve GP workforce planning precision and development quality.

Author Contributions: CHEN Dongran and XU Peilan conceptualized the study; CHEN Dongran conducted literature search, data extraction and analysis, and drafted the manuscript; DING Lei verified data and proofread the manuscript; LI Yuhua provided quality control and overall supervision.

Conflict of Interest Statement: The authors declare no conflicts of interest.

Received: February 10, 2024; **Revised:** September 18, 2024; **Accepted:** [Not provided]

References

[1] GUO Xiangqian. Building a health standard system with Chinese characteristics[N]. China Family News, 2022-02-21(8).

[2] CHEN Jingjing, LI Yanlan, TIAN Xuebin, et al. Equity and forecast analysis of general practitioner resource allocation in China[J]. Soft Science of Health, 2021, 35(2): 62-65. DOI:10.3969/j.issn.1003-2800.2021.02.015.

[3] ZHOU Minghua, FENG Yi. Research on the status and equity of health resource allocation in northern Guizhou[J]. Modern Hospital Management, 2019, 17(3): 1-4. DOI:10.3969/j.issn.1672-4232.2019.03.001.

[4] DAI Mengna, XI Yan, YIN Wenqiang, et al. Equity analysis of regional health resource allocation in Shandong Province based on agglomeration degree[J]. Chinese Journal of Health Statistics, 2021, 38(5): 642-645, 649. DOI:10.3969/j.issn.1002-3674.2021.05.001.

[5] ZHANG Huayu, MIAO Yudong, QU Xiaoyuan, et al. Equity analysis of general practitioner resource allocation in China based on Lorenz curve and Gini coefficient[J]. Chinese General Practice, 2020, 23(4): 409-413. DOI:10.12114/j.issn.1007-9572.2019.00.783.

[6] WANG Xia, LUO Fuyong. Analysis and forecast of future population development in Xinjiang[J]. Journal of Xinjiang University of Finance and Economics, 2007(4): 25-29. DOI:10.3969/j.issn.1671-9840.2007.04.007.

[7] JING Qi. Evaluation and forecast of health resource allocation in Shandong Province[D]. Jinan: Shandong University, 2016.

[8] CHENG Yanmin, XU Yanfei, WEN Nan, et al. Analysis of general practitioner allocation and equity trends in Shandong Province, 2013–2016[J]. Chinese General Practice, 2020, 23(4): 414-418. DOI:10.12114/j.issn.1007-9572.2020.00.019.

[9] LI Wan, HAN Caixin. Equity analysis of general practitioner allocation in western China—Based on Gini coefficient and agglomeration degree[J]. Health Economics Research, 2020, 37(9): [page numbers not provided].

[10] JI Yan, YAN Chunze, SUN Yangge, et al. Forms and applications of continuing medical education for general practitioners[J]. Chinese General Practice, 2021, 24(1): 88-91. DOI:10.12114/j.issn.1007-9572.2019.00.715.

[11] GANG Jun, MA Xiuhua, DU Yaqiong, et al. Impact of general practice departments on satisfaction with standardized general practice training[J]. China Continuing Medical Education, 2020, 12(9): 36-38. DOI:10.3969/j.issn.1674-9308.2020.09.015.

[12] QIAO Guanhua, LIAO Peng, JIA Jinzhong, et al. Equity analysis of general practitioner allocation in China[J]. Chinese General Practice, 2020, 23(13): 1606-1610. DOI:10.12114/j.issn.1007-9572.2020.00.074.

[13] MENG Jiayu, LI Yuyang, QIN Shangren, et al. Regional equity analysis of health human resources in primary healthcare institutions in Zhejiang Province[J]. Chinese Journal of Social Medicine, 2020, 37(3): 299-302. DOI:10.3969/j.issn.1673-5625.2020.03.021.

[14] GU Long, Haili Qimu · Abudubari, Maimaiti · Yasen. Equity analysis of health human resources in Xinjiang based on Gini coefficient[J]. Chinese Journal of Health Statistics, 2018, 35(1): 83-85.

[15] WANG Wei, LI Yuanju, MA Luye, et al. Equity evaluation of health human resources in Henan Province based on agglomeration degree[J]. Chinese Hospital Management, 2017, 37(8): 48-49+73. DOI:1001-5329(2017)08-0048-03.

[16] HUANGFU Huihui, LI Hongyan. Equity analysis of general practitioner resource allocation in China—Based on Theil index and grey forecasting method[J]. Health Economics Research, 2018(11): [page numbers not provided].

[17] LI Peng. Research on the operation of general practitioner conversion training in Xinjiang township health centers[D]. Urumqi: Xinjiang Medical University, 2020.

[18] XU Peilan, WANG Jiasui, Muri Zhamai · Maimaiti, et al. Status analysis of health human resource allocation in township health centers of four southern Xinjiang prefectures based on rank-sum ratio method[J]. Chinese Journal of Health Statistics, 2020, 37(4): 617-619.

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

Source: ChinaXiv —Machine translation. Verify with original.