


BMJ Open Does increasing physician volume in primary healthcare facilities under the hierarchical medical system help reduce hospital service utilisation in China? A fixed-effects analysis using province-level panel data

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ABSTRACT

Objective To examine whether increases in physician volume in primary healthcare facilities are associated with reduced utilisation of hospital outpatient and inpatient services after China facilitated the establishment of the hierarchical medical system.

Design We used a two-way fixed-effects regression to examine the association between the annual number of physicians in primary healthcare facilities and that of patient visits per physician, inpatient admissions and total expenses per outpatient visit in public hospitals during 2010–2014 and 2015–2019. Variables were log transformed to ensure the normal distribution of the data.

Setting Province-level data of all 31 provinces in mainland China from 2010 to 2019 were collected from the China Health Statistics Yearbook published by the China Health Commission.

Participants All 31 provinces in mainland China.

Primary and secondary outcome measures The annual number of outpatient visits per physician, hospital admission and total expenses per outpatient visit in public hospitals.

Results During 2015–2019, we found that, on average, a 1% increase in the number of primary healthcare physicians was accompanied by a 0.19% (95% CI –0.33% to –0.05%) reduction in the annual number of visits per physician in public hospitals, and a 0.31% (95% CI –0.52% to –0.10%) reduction in patient visits in city-administered hospitals. No significant associations were found between 2010 and 2014. We also did not observe any significant associations between primary healthcare physician volume and hospital admissions or outpatient expenses during neither 2010–2014 and 2015–2019.

Conclusions In the context of the hierarchical medical system, enhancing physician volume in primary healthcare facilities helps reduce outpatient visits in public hospitals, especially city-administered hospitals. However, more efforts are required to be continuously made to improve primary healthcare capacity to avoid preventable hospital admissions and outpatient expenses.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ We constructed a two-way fixed-effects model which included fixed effects for time to adjust for secular changes in outcomes, and province to account for all unmeasured differences across provinces that do not vary in time. We also directly controlled for other observable characteristics that are likely to affect the outcomes.
- ⇒ We conducted a subgroup analysis to investigate the heterogeneity of the relationship between primary healthcare physician volumes and the service utilisation of hospitals with different administrative levels.
- ⇒ The study limitations mainly include omitted variable bias, the ecological fallacy that province-level data cannot detect changes at the individual level and that this study's observational design cannot infer causality.

INTRODUCTION

Primary healthcare is an essential component of the global healthcare system.¹ Many countries, especially high-income countries, have a well-established primary healthcare system. In the USA, community health centres serve as primary medical homes for approximately 30 million residents in more than 13 000 underserved communities across the country.² In the UK, primary healthcare provides approximately 90% of all patient contacts.³ In contrast to high-income countries, primary healthcare in China is less developed.⁴

China's three-tier healthcare system includes primary healthcare facilities, and secondary and tertiary hospitals.⁵ Primary healthcare facilities include township health centres, village clinics in rural areas and community health centres or stations in

urban areas. In China's hospital system, public hospitals deliver over 90% of all inpatient and outpatient services, and tertiary public hospitals, the highest level, are usually large in size, located in big cities and well financed.⁶ Because of the uneven distribution of medical resources, public hospitals are equipped and staffed better than primary healthcare facilities.^{7 8} Unlike England and Germany, where there is a mandatory gatekeeper system through legislation, China does not have a strict 'gatekeeper' system. Patients can easily bypass primary healthcare facilities and go directly to secondary or tertiary hospitals for basic care, without any legal or financial punishment.⁹ This results in public hospitals, especially tertiary hospitals, often being overwhelmed, which easily leads to a poor doctor–patient relationship.^{10–12}

To reallocate medical resources, alleviate the outpatient service burden in large hospitals and strengthen role of primary healthcare as gatekeeper, China introduced the concept of the hierarchical medical system to help form a hierarchical order for delivering medical services in the 2009 healthcare reform.¹³ Measures were implemented from the supply side, such as introducing the two-way referral system and improving the staffing capacity of primary healthcare facilities and from demand side, including the reform of the medical insurance reimbursement system. Under the hierarchical medical system, primary healthcare facilities and hospitals are connected through a 'two-way referral' system. Primary healthcare facilities serve as patients' first contact for healthcare, responsible for their initial diagnosis of common diseases and referrals. General practitioners working in primary healthcare facilities assume the role of gatekeepers for referrals to hospitals. Meanwhile, hospital physicians can refer patients to primary healthcare facilities for rehabilitation or other basic treatments. Secondary hospitals provide specialised care and receive patients in recovery from acute or critical diseases as well as patients referred by tertiary hospitals, while tertiary hospitals mainly focus on the diagnosis and treatment of more complicated conditions.¹⁴ From 2009 over the next 5 years, 16 provinces piloted the hierarchical medical system, but a lack of experience meant they developed diverse systems that functioned poorly.¹⁵ Therefore, to promote a consistent national effort, in September 2015, the State Council of China issued a national policy to enforce the establishment of the hierarchical medical system nationally.¹⁶

In addition to the supply-side mechanisms, from 2009, China also implemented financial incentives for patients to promote the use of primary healthcare facilities by offering higher or lower reimbursement rates depending on their choice.¹³ In most regions, if patients go directly to hospitals without a referral by a physician from a primary healthcare facility, their insurance reimbursement rates could be reduced by 10%–20% or even cancelled.¹⁷ For example, in urban areas, basic employee medical insurance can cover 80% of outpatient expenses.^{7 18} In some cities, such as Beijing, the reimbursement rate for using primary healthcare facilities can reach 90%, whereas the

rate is only 70% by comparison if hospital outpatient services are used.¹⁹

Other than implementing system reforms, China has been strengthening its primary healthcare system by improving the staffing capacity of its facilities. From 2010–2019, the number of physicians in primary healthcare facilities increased from 949 000 by approximately 51% to 1 437 000.^{20 21} The number of total patient visits to primary healthcare facilities also increased from 3 612 000 by 25% to 4 531 000 during the same period.^{20 21} In particular, the increase in the number of primary healthcare physicians was faster during 2015–2019 (from 1 102 000 by 30.4% to 1 437 000) compared with the 2010–2014 period, before China facilitated the hierarchical medical system (from 949 000 by 12.1% to 1 064 000).^{20–23} Improving the physician staffing capacity in primary healthcare facilities is a key workforce strategy to strengthen China's primary healthcare system and eventually improve the use of primary healthcare facilities by diverting patient flows from hospitals. Therefore, it is important to understand whether the improved physician capacity in primary healthcare facilities helps further reduce hospital service utilisation under the context of the hierarchical medical system. Several studies in developed countries, such as the UK and Australia, as well as studies in China, have shown that increasing access to primary healthcare services is associated with reduced hospital outpatient visits and inpatient admissions.^{24–28} However, evidence on the association between physician staffing improvement and hospital utilisation after China facilitated the establishment of the hierarchical medical system is still lacking.

In this study, we used 2010–2019 province-level data from 31 provinces in mainland China to examine the association between an increase in the number of physicians in primary healthcare facilities and the utilisation of outpatient and inpatient services in public hospitals. In particular, we investigated whether the relationship between physician volume in primary healthcare facilities and hospital utilisation changed before and after China established the hierarchical medical system. The findings of this study can offer critical insights into ways to reduce the underutilisation of primary healthcare services and provide important implications for the future implementation of the hierarchical medical system in China.

METHODS

Data source

The primary data sources were the 2011–2020 China Health Statistics Yearbook, published annually by the National Health Commission, and the 2011–2020 China Statistical Yearbook, published annually by the National Bureau of Statistics of China. The China Health Statistics Yearbook includes healthcare-related information for each province, such as patient visits and staffing in different healthcare settings, facility characteristics and other information. The China Statistical Yearbook includes socio-economic information for each province,

2010

2019

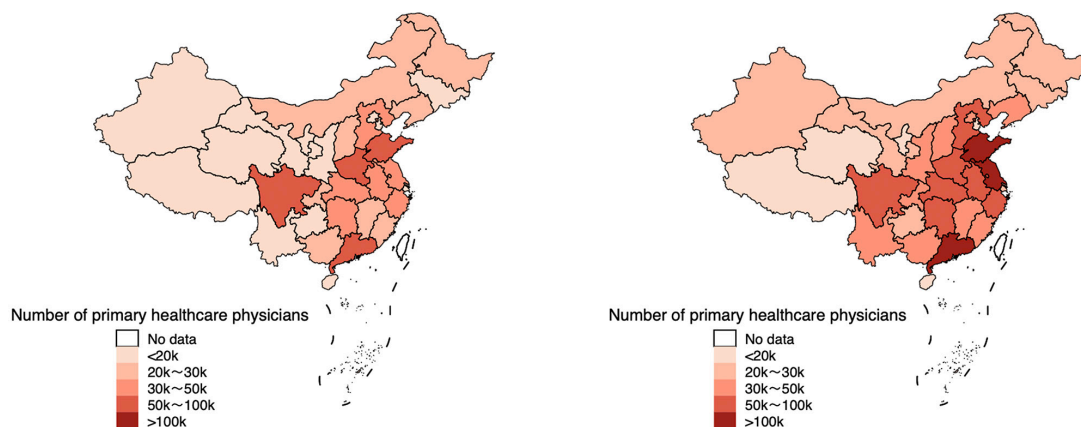


Figure 1 Geographical distribution of primary healthcare physicians in 2010 and 2019.

such as population size, population demographics, gross domestic product (GDP) per capita and other related information. The two data sets were merged using provincial identification.

Outcomes and measures

In this study, we examined three sets of hospital outcomes: (1) the annual number of patient visits per physician in public, city-administered, and province-administered hospitals; (2) the annual number of public hospital admissions; and (3) total expenses per outpatient visit in public hospitals. In China, both province-administered and city-administered hospitals are public hospitals located in urban areas but are different in their administrative and financial authorities. A province-administered hospital is administered and financially supported by the provincial government, whereas a city-administered hospital is administered and financially supported by the city government. Medical resources tend to be concentrated in these two types of hospitals, especially in province-administered hospitals, which are usually large tertiary hospitals.

The key explanatory variable was the annual number of physicians in primary healthcare facilities, including community health centres in urban areas, township health centres and village clinics in rural areas. Both the outcome and explanatory variables were log transformed to ensure the normal distribution of data and present the estimated effects as elasticities.

Statistical analysis

The unit of analysis was the province-year. We constructed a panel of 31 provinces in mainland China, yielding a 310-province-year from 2010–2019. We used a two-way fixed-effects linear regression model to examine the association between primary healthcare physician volume and hospital outcome. In the model, the dependent variable was each of the logged hospital outcomes mentioned above, and the key independent variable was the logged number of physicians in primary healthcare facilities. We included year fixed effects to adjust for secular changes

in outcomes and province fixed effects to account for all unmeasured differences across provinces that did not vary over time. We also controlled for other observable time-varying province characteristics, including the percentages of female provincial populations, aged ≥ 65 , rural residents, uninsured and without a bachelor's degree, as well as the share of tertiary hospitals among total public hospitals, medical expenditure as a percentage of GDP, unemployment rate, mortality rate and per-capita disposable income of urban residents in each province. Means of the control variables are reported in online supplemental appendix table 1. The model specification is as follows:

$$\log Y_{it} = \beta_0 + \beta_1 \log PHP_{it} + \mathbf{X}_{it}'\tau + \lambda_i + \delta_t + \epsilon_{it}$$

where $\log Y_{it}$ is the log-transformed hospital outcome in province i and year t . $\log PHP_{it}$ is the log-transformed number of primary healthcare physicians in province i and year t . \mathbf{X}_{it}' is a set of time-varying control variables mentioned above. λ_i and δ_t indicate the province and year fixed effects, respectively.

We weighed all models by provincial population to account for variation in province size. We clustered SEs by province to account for problems potentially caused by heteroscedasticity or serial correlations. We ran the model for 2010–2014 and 2015–2019 to examine whether the association between physician volume and hospital outcomes held before and after China established of the hierarchical medical system. Regression coefficients and the corresponding 95% CIs were reported. For better interpretation, we extrapolated the scale of significant coefficients by simply multiplying the coefficient by 10 to reflect decreases in adjusted patient visits to public hospitals with a 10% increase in primary healthcare physician volume. The significance level was set at 0.05 using two-tailed tests.

All analyses were performed using Stata V.17 (StataCorp, Chicago, Illinois, USA).

Table 1 Five-year growth rate of hospital outpatient visits, outpatient expenses and inpatient admissions during the periods of 2010–2014 and 2015–2019

	Five-year growth rate				
	2010 mean	2014 mean	2010–2014 growth rate (%)	2015 mean	2015–2019 growth rate (%)
The annual number of outpatient visits per physician in all public hospitals	1676.98	1908.83	13.83	1863.50	1.39
City-administered hospitals	1650.84	1836.33	11.24	1797.13	2.06
Province-administered hospitals	1763.60	2045.56	15.99	2008.13	-1.84
The annual number of inpatient admissions in public hospitals	389 671 9.00	598 6857.00	53.64	610 9106.00	27.48
Total expenses per outpatient visit in public hospitals	164.41	211.62	28.71	224.62	22.76

Data were weighted by provincial population to account for province size.

Sensitivity analysis

Because the policy was implemented in mid-September 2015, we also conducted a sensitivity analysis using 2016–2019 as the post implementation period of facilitating the hierarchical medical system and re-ran all models. The results were similar to those of the original models and are presented in online supplemental appendix table 2.

Patient and public involvement

No patients and the public were involved in this study.

RESULTS

Geographic distribution of primary healthcare physicians

Figure 1 shows the geographic distribution of primary healthcare physicians in 2010 and 2019. In 2010, primary healthcare physicians were mostly concentrated on the east coast of China, usually the high-income regions of China. The uneven distribution aggravated in 2019. The inequality in the number of primary healthcare physicians in the eastern provinces intensified, whereas the inequality changed little in the middle and western regions. The concentration indices of primary healthcare physicians in 2010 and 2019 were 0.301 (95% CI -0.001 to 0.603, $p=0.060$) and 0.560 (95% CI 0.186 to 0.934, $p=0.007$), respectively (see online supplemental appendix table 3). These indices were calculated based on the average number of primary healthcare physicians per capita and the average per-capita disposable income, using the method proposed by Wagstaff and van Doorslaer.²⁹

Growth of hospital services and expenses

Table 1 shows the growth rates of hospital services and expenses during 2010–2014 and 2015–2019. During 2010–2014, the annual number of outpatient visits per physician in public hospitals increased by 13.83% from 1676.98 to 1908.83 (see online supplemental appendix figure 1). This growth was similar in city-administered (11.24%) and province-administered (15.99%) hospitals. By contrast, during 2015–2019, outpatient visits per physician increased only slightly by 1.39% in all public hospitals and by 2.06% in city-administered hospitals. Outpatient visits per physician in province-administered hospitals decreased by approximately 1.84% during the same period. The annual number of inpatient admissions in public hospitals increased rapidly by 53.64% from 3896719 to 5986857 between 2010 and 2014. Although inpatient admissions continued to increase after 2015, the growth slowed down substantially (27.48%). Meanwhile, the growth in total expenses per outpatient visit was similar between 2010–2014 and 2015–2019 (28.71% and 22.76%, respectively).

Relationship between primary healthcare physician volume and hospital outcomes

Tables 2 and 3 present the adjusted regression estimates from the two-way fixed-effects models. The full regression

Table 2 Adjusted regression results of associations between primary healthcare physician volume and hospital outpatient visits, 2010–2014 vs 2015–2019

	Natural log of the annual number of outpatient visits per physician					
	All public hospitals		City-administered hospitals		Province-administered hospitals	
	2010–2014 Coefficient (95% CI)	2015–2019 Coefficient (95% CI)	2010–2014 Coefficient (95% CI)	2015–2019 Coefficient (95% CI)	2010–2014 Coefficient (95% CI)	2015–2019 Coefficient (95% CI)
Natural log of primary healthcare physician volume	-0.088 (-0.282, 0.106)	-0.190*** (-0.327, -0.054)	0.113 (-0.205, 0.430)	-0.310*** (-0.516, -0.104)	-0.187 (-0.650, 0.277)	-0.328 (-0.753, 0.098)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Observations (n)	155	155	155	155	155	155
R ²	0.744	0.676	0.395	0.567	0.465	0.232

This table presents the results of multivariate ordinary least squares regression analyses using data for the periods of 2010–2014 and 2015–2019 for three dependent variables: the natural log of the annual number of visits per physician in public hospitals, province-administered hospitals and city-administered hospitals. All models were adjusted for province and year fixed effects and controlled for the percentages of populations who are female, aged 65 or above, rural residents, uninsured and without a bachelor's degree, as well as mortality, the percentage of tertiary hospitals in public hospitals, medical expenditure as a per cent of gross domestic product (GDP), unemployment rate and the per-capita disposable income of urban residents (¥1000). All models were weighted by provincial population to account for province size. SEs were clustered at the province level.
 FE, fixed effects.
 ***P<0.001.

results with control variables are provided in the online supplemental material. During 2010–2014, no significant associations were found between primary healthcare physician volume and hospital outpatient visits (table 2; see online supplemental appendix table 4 for full regression results). By contrast, after controlling for province- and year-fixed effects and other variables, we found that a 1% increase in the number of primary healthcare physicians was significantly associated with a 0.19% (95% CI -0.33% to -0.05%, p=0.008) decrease in the number of outpatient visits per physician in all public hospitals and, in particular, a larger reduction (-0.31%, 95% CI -0.52% to -0.10%, p=0.004) in city-administered hospitals from 2015–2019. However, we did not find a significant association between primary healthcare physician volume and outpatient visits to province-administered hospitals during this period. In addition, during both 2010–2014 and 2015–2019, increases in the number of physicians in primary healthcare facilities were not associated with hospital inpatient admissions and total expenses per outpatient visit in our models (table 3; see online supplemental appendix table 5 for full regression results).

Relative decreases in adjusted patient visits in public hospitals with increases in primary healthcare physician volume

For better interpretation, we extrapolated the scale of significant coefficients by simply multiplying the coefficient by 10 to reflect decreases in adjusted patient visits to public hospitals with a 10% increase in primary healthcare physician volume (table 4). Holding other variables constant, a 10% relative increase in primary healthcare physicians per province was significantly associated with a 1.90% relative reduction in the adjusted annual number of patient visits per physician in public hospitals during 2015–2019. We also estimated that a 30% relative increase in the number of primary healthcare physicians would be significantly associated with a 5.70% relative reduction in the number of patient visits per physician in public hospitals, holding other variables constant.

DISCUSSION

To the best of our knowledge, this is the first national study to use province-level administrative data to examine the association between an increase in physician volume in primary healthcare facilities and the unitisation of hospital inpatient and outpatient services in China. Our findings indicated that an increase in the number of physicians in primary healthcare facilities was significantly associated with reductions in hospital outpatient visits at the provincial level after China issued its national policy to facilitate the establishment of the hierarchical medical system across the country. We also found a relatively larger effect of primary healthcare physicians' volume increases on patient visits in city-administered hospitals, which are usually tertiary hospitals located in urban areas. By contrast, we did not observe such associations before

Table 3 Adjusted regression results of associations between primary healthcare physician volume and hospital inpatient admission and outpatient expenses, 2010–2014 vs 2015–2019

	Natural log of public hospital admission		Natural log of total expenses per outpatient visit	
	2010–2014 Coefficient (95% CI)	2015–2019 Coefficient (95% CI)	2010–2014 Coefficient (95% CI)	2015–2019 Coefficient (95% CI)
Natural log of primary healthcare physician volume	–0.091 (–0.240, 0.058)	–0.087 (–0.260, 0.086)	–0.131 (–0.281, 0.197)	–0.040 (–0.165, 0.085)
Province FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes
Observations (n)	155	155	155	155
R ²	0.984	0.949	0.942	0.950

This table presents the results of the multivariate ordinary least squares regression analyses using data for the periods of 2010–2014 and 2015–2019 for two dependent variables: the natural log of public hospital admission and the natural log of total expenses per outpatient visit. All models were adjusted for province and year fixed effects and controlled for the percentages of populations who are female, aged 65 or above, rural residents, uninsured and without a bachelor's degree, as well as mortality, the percentage of tertiary hospitals in public hospitals, medical expenditure as a per cent of gross domestic product (GDP), unemployment rate and the per-capita disposable income of urban residents (¥1000). All models were weighted by provincial population to account for province size. SEs were clustered at the province level. FE, fixed effects.

the policy was implemented or in province-administered hospitals. These findings suggest that, with the establishment of the hierarchical medical system, enhancing physician staffing capacity in primary healthcare facilities could help further alleviate the outpatient service burden in public hospitals, but may not do so in extremely large tertiary hospitals.

The implementation of the two-way referral system under the hierarchical medical system connects primary healthcare facilities with higher level hospitals through upward and downward patient referrals, promoting the role of primary healthcare facilities as ‘gatekeepers’ in the referral process. This national policy has been effective in changing patients’ health-seeking behaviour by increasing the probability of urban residents using community health centres as their usual source of care.¹⁷ Our findings add to the literature by showing that under the hierarchical medical system, strengthening the primary healthcare system by enhancing primary healthcare physicians’ staffing capacity could further help to boost the diversion of patient flows from hospitals. An improvement in primary healthcare facilities resulted

in a substitutional effect between them and higher level hospitals in terms of providing basic medical services.

However, our results also indicated that such an effect may not be realised between primary healthcare facilities and province-administered hospitals. A prior study in Shanghai, China, found that quality of care is the most important factor that drives patients to use tertiary hospitals.³⁰ Province-administered hospitals have high reputations and better resources, and the stereotype that better resources imply better quality among Chinese patients may not be easily changed in a short time. Although city-administered hospitals also consist of tertiary hospitals, the resources, reputations and patient trust are still lower than those of province-administered hospitals. This also suggests that more efforts are still required to improve the quality of care in primary healthcare facilities, even with an improved number of physicians.

It should also be noted that when extrapolating the scale of estimates of relative decreases in adjusted hospital outpatient visits, increasing primary healthcare physician volume relates to a relatively small reduction in hospital outpatient visits (less than a 10% reduction in hospital visits with a 50% increase in the number of primary healthcare physicians). Future policies for improving primary healthcare capacity should consider the cost-effectiveness of investing in staffing investments in primary healthcare facilities. There is evidence showing that increasing the number of physicians in community health centres in areas with more severe physician shortages has a significant effect on increasing health centre patient visits compared with areas with less severe physician shortages in the USA.³¹ Given that China also suffers from a severe maldistribution of primary healthcare staffing, policies focused on reallocating human resources for health by enhancing primary healthcare staffing in western areas of China may help expand the effectiveness of staffing investment.

Theoretically, strengthening primary healthcare services is expected to reduce hospital admissions owing to ‘early prevention’, thus further reducing healthcare expenditures.³²

Table 4 Estimated relative decreases in hospital outpatient visits per physician with increases in primary healthcare physician volume, 2015–2019

Increase in primary healthcare physician volume (%)	Estimated relative decreases in the annual number of patient visits per physician in public hospitals
10	1.90
20	3.80
30	5.70
40	7.60
50	9.50

This table estimates the relative decreases in the annual number of patient visits in public hospitals with a 10%–50% increase in primary care physicians, holding other variables constant at their means. For better interpretation, we extrapolated the scale of significant coefficients by simply multiplying the coefficient by 10 to reflect a 10-point decrease in adjusted patient visits in public hospitals with increases in primary healthcare physician volume. All estimates are significant at the 0.001 level.

Prior empirical evidence showed that increasing primary healthcare physician supply was associated with reduced per-capita hospital medical expenditures in China during 2012–2016.³³ However, in our model, we did not find significant associations between increases in primary healthcare physician volume and reductions in public hospital inpatient admissions or outpatient expenses, either before or after the national policy was implemented. Our findings are consistent with those of a previous study in the UK, where increases in primary healthcare services were not associated with reduced hospital activity or expenditure.²⁵ It should be noted that the UK has a strict gatekeeping system that requires referral from primary healthcare facilities in order to obtain hospital care. Although China does not have such a strict referral system, primary healthcare facilities are taking on a similar role as gatekeepers under the hierarchical medical system.

Our study's observational design could not answer why, but we suspect that the two-way referral system might contribute to the reasons that there was no significant association between enhancing primary healthcare physicians and healthcare expenditures. On one hand, family physicians may refer patients to hospitals to improve their own performance evaluation, or as requested by patients rather than based on the real care demand derived from a diagnosis. This would in turn boost the use of hospital inpatient services. A review article focusing on a two-way referral in China from 1997–2017 found that the number of upward-referred patients was much greater than that of downward-referred patients, and the reasons included a lack of motivation and risk aversion behaviours of primary healthcare physicians, as well as a lack of clear referral criteria and procedures.³⁴ On the other hand, it is also possible that hospitals do not have an incentive to downward refer patients owing to the revenue effect, or that patients are unwilling to be referred back to primary healthcare facilities because of the impression that hospitals have a better quality of care.³⁵ Policymakers should thus consider redefining referral mechanisms and enhancing supervision to reduce unnecessary upward hospital referrals and improve the downward referral pathway. Efforts should also be made to improve the capacity of primary healthcare facilities to avoid preventable hospitalisation. Future research is required to investigate more in-depth reasons for this issue using other data sources or qualitative methods, such as interviews.

Our study contributes new evidence to the current understanding of workforce investment in enhancing primary healthcare and reducing hospitalisation. Existing literature on the effectiveness of the hierarchical medical system mainly focuses on policies that provide monetary incentives to patients at the local level. A study using an individual-level insurance claim data set from one megacity in China reported that policies to encourage patients to use primary healthcare services by reducing their cost sharing did not affect the likelihood of having avoidable inpatient admissions.²⁸ Findings from a study in Shandong province also suggested that inpatient out-of-pocket expenses for primary healthcare facilities

fell by less than half as much as they did for secondary and tertiary hospitals over the period of 2015–2017, the precise opposite of the goal of the hierarchical medical system.¹⁴ However, very few previous studies have touched on the role of increasing the number of primary healthcare physicians in reducing hospital admissions and the expenses of hospital services. Future research is warranted to revisit this study and investigate the relationship between primary care usage and hospital expenditures in China's healthcare system.

Limitations

This study had several limitations. First, no causal relationship could be inferred from our analysis due to the study's observational design. Second, because we used province-level data, any inferences at the individual level (ie, ecological fallacy) should be avoided.³⁶ Third, our findings suffer from omitted variable bias. Because of data availability, we were unable to control for all relevant confounders related to hospital outcomes, such as medical equipment, healthcare quality and health status of the population. Other policies the government has adopted, such as the insurance reforms to promote the use of primary healthcare facilities, could be time-varying confounders. However, as most of these policies have been implemented since the 2009 reform,^{13 37} the time frame of which is covered by the whole period of our study (2010–2019), they may not have a differential impact on our findings.

CONCLUSIONS

Enhancing physician volume in primary healthcare facilities is an effective way to help reduce outpatient visits to public hospitals after the national inception of the hierarchical medical system in China. However, compared with the original goals of China's hierarchical medical system initiative, efforts need to be made continuously to improve primary healthcare quality and provide primary healthcare with a greater role in reducing preventable hospital admissions and outpatient expenses.

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Contributors XH accepts full responsibility for the work and the conduct of this study, had access to the data, and controlled the decision to publish. XH was responsible for the conception of this study, and supervised the data analysis. XL analysed the data and drafted the paper. XH, HX and FD contributed to critical revisions of the paper. BZ, PX and HW gave advice on statistical analysis. All authors have given final approval of the version to be published.

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