International Journal for Equity in Health

RESEARCH Open Access

Healthcare resource allocation and patient choice: evidence from rural China

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Abstract

Access to quality essential healthcare services is a fundamental right for all residents. However, the unequal allocation of healthcare resources affects patients' accessibility to care, thereby influencing their healthcare choices. Utilizing health insurance administrative data and employing a difference-in-differences (DID) model, this study examines the impact of China's healthcare resource allocation reform on patients' healthcare choices. The findings reveal that increased investment in rural healthcare resources significantly reduces the proportion of residents seeking medical services outside their counties, alleviates patients' medical burden, and enhances healthcare quality. Notably, these improvements primarily benefit patients with common diseases, while the impact on those with rare diseases remains less pronounced. These results underscore the importance of strengthening the comprehensive capabilities of county-level hospitals and prioritizing high-quality resource allocation in rural areas as key directions for future reforms in healthcare system.

Keywords Healthcare resource allocation, Patient choice, Healthcare burden, Healthcare quality

Introduction

Optimizing the allocation of healthcare resources is a worldwide challenge, especially for developing countries [19]. China's healthcare resources face a dual challenge of insufficient overall quantity and structural imbalances [5, 22, 34], among which the unbalanced distribution of healthcare resources in urban and rural areas are particularly prominent [18, 20]. Currently, high-quality healthcare resources in China are primarily concentrated in urban areas, while rural areas lag behind both in terms of the quantity and quality of healthcare resources [23, 39]. Rural residents are constantly crowding into urban hospitals in order to obtain high-quality medical services. Urban hospitals are overcrowded, while rural primary hospitals have idle medical resources, resulting in inefficient utilization of medical resources [31].

In recent years, strengthening primary healthcare has become a focal point of China's healthcare system reform. The goal is to improve the urban–rural distribution of high-quality healthcare resources and increase the supply of healthcare resources in rural areas. County-level hospitals, serving as the hub of urban–rural healthcare systems and leading providers of healthcare services in rural areas, are the primary targets of this reform. The enhancement of their service capabilities has a profound impact on optimizing the allocation of urban–rural healthcare resources. Previous studies have extensively studied the unequal distribution of urban–rural healthcare resources but has rarely explored the impact of healthcare resource allocation on patient healthcare-seeking behavior. County-level hospitals, as integral components of rural healthcare resources, represent high-quality healthcare resources in rural areas. Therefore, this study focuses on the reform of county-level hospital capabilities, analyzing the effects of improved

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healthcare resource allocation in rural areas on residents' healthcare choices, financial burdens, and healthcare quality. Furthermore, it delves into the mechanisms underlying these effects, aiming to provide empirical evidence for optimizing healthcare resource allocation.

The marginal contributions of this study are primarily evident in three key areas. Firstly, this study leverages the policy environment of the reform for improving the capabilities of county-level hospitals in rural areas. Using administrative data from health insurance, the study investigates the impact of the allocation of high-quality healthcare resources to rural areas on patients' choices of healthcare services from the perspective of supply. Our results contribute to the literature on choice in health care and provides a valuable supplement to existing literature. Secondly, this study explores the mechanisms by which the allocation of healthcare resources influences patients' choices of healthcare services, offering new insights into addressing the issue of hospital overcrowding caused by the excessive concentration of resources. Thirdly, based on the realistic challenges in the allocation of healthcare resources in rural areas of China, this study empirically examines the feasibility and limitations of the input patterns to the regional leading hospitals. This offers experiential insights for developing countries aiming to optimize the allocation of healthcare resources between urban and rural areas.

Literature review

There are many factors that influence patient choice, such as gatekeeper system, price incentives, and quality of care. The gatekeeper system is considered a crucial mean for managing patient healthcare choice and reducing disorderly visits, thereby promoting the rational use of healthcare resources [15]. China's healthcare system lacks general practitioner gatekeepers, allowing patients to freely choose their healthcare providers [37]. By setting a tiered medical insurance reimbursement ratio, the government sets a higher reimbursement ratio for primary healthcare institutions, so as to use the incentive mechanism to guide patients to seek medical treatment in the community [30]. However, price guidance does not play an effective role. Quality of care is an important factor in patient choice [3, 24]. Gutacker et al. [17] found that a one standard deviation increases in average health gain increases demand by up to 10%. The same conclusion holds true in the choice of family doctor [27].

A significant proportion of China's high-quality healthcare resources is concentrated in urban areas. As a result, patients often bypass rural primary healthcare centers to seek treatment at urban hospitals, perpetuating a vicious cycle of deteriorating rural healthcare facilities. The unequal distribution of healthcare resources between urban and rural areas in China is deeply rooted in systemic development patterns. Firstly, the transition from government-planned healthcare resource allocation to market-oriented reforms has exacerbated this disparity. Objective factors, such as income gaps between urban and rural areas, have driven a continuous migration of medical professionals and patients toward large urban hospitals, further widening the divide [7]. Secondly, China's healthcare system operates on an administrative hierarchy model, where higher-level hospitals receive more government financial input. This incentivizes the concentration of high-quality healthcare resources in urban major hospitals [9]. Thirdly, Chinese hospitals often pursue excessive expansion, leading to a siphoning effect on rural and primary healthcare resources. This exacerbates the disparities in the quantity and quality of resources between urban and rural healthcare institutions [32]. Fourthly, in the healthcare market with asymmetric information, hospital tier often becomes synonymous with healthcare quality, further reinforcing the siphoning effect of patients towards urban hospitals [23]. Under the influence of various factors, advantageous healthcare resources are concentrated in urban hospitals, and urban hospitals are developing in large scale or even in groups, while the diagnosis and treatment functions of common diseases and chronic diseases in primary health care institutions are weakening gradually [31]. However, primary health care is often regarded as a crucial element of global health systems to cope with numerous health challenges, from the prevention and management of chronic diseases to reducing mortality rates [8, 25].

The core concept of healthcare resource allocation and patient choice lies in the principle of hierarchic healthcare, which has been applied internationally for a longer period. Hierarchic healthcare involves vertically integrating healthcare services by uniting healthcare institutions of different levels within a region through models like medical groups. These institutions collaborate through specialization and cooperation, effectively improving the accessibility and equity of healthcare resources. Additionally, it enhances patients' utilization of primary healthcare services, ultimately reducing patients' medical expenses [2, 4, 10, 11, 14]. Internationally, notable models of hierarchic healthcare include the UK's "gatekeeper system" based on family doctors [16, 12] and Japan's "three-tiered healthcare system". The structural imbalance in the allocation of healthcare resources reduces the efficiency of resource utilization, leading to issues of unfairness in healthcare resource utilization [31, 36].

Institutional background

In rural China, the healthcare service network is structured into three levels: county, township, and village. County-level healthcare institutions serve as the leaders of this system, with township health centers forming the core, and village clinics serving as the foundation. This healthcare system primarily provides preventive care, health education, disease management, the establishment of health records for residents, diagnosis and treatment of common and prevalent diseases, and rehabilitation and nursing care for certain illnesses. County-level hospitals play a pivotal role in this system. On one hand, they serve as crucial gatekeepers for rural healthcare services, leading the three-tier healthcare network. They handle the diagnosis and treatment of common and prevalent diseases within their county, as well as emergency medical care. On the other hand, county-level hospitals act as hubs connecting urban and rural healthcare by providing referral services for complex and difficult cases. However, the structure of healthcare resource allocation exhibits an "inverted triangle" pattern, where healthcare resources are concentrated in higher-tier medical institutions while primary healthcare facilities face resource shortages [1, 13, 26]. The urban–rural healthcare resource gap has been gradually widening, and county-level hospitals, representing the quality of rural healthcare, have been severely lagging in development, making it challenging to meet the medical service demands of residents within counties [35]. As shown in Fig. 1, despite the continuous growth in the total quantity of healthcare resources in county-level hospitals over time, their proportion has been steadily decreasing since 2014.

In response to this challenge, China has continuously strengthened its investment in healthcare resources in rural areas, with a particular focus on specialized support policies aimed at county-level hospitals. These policies are designed to enhance the capabilities of county-level hospitals, thereby improving the accessibility and equity of high-quality healthcare resources in rural areas. In October 2018, the National Health Commission (NHC) and the State Administration of Traditional Chinese Medicine (SATCM) issued a notice titled "Work Programme for Enhancing the Comprehensive Capacity of County-Level Hospitals (2018–2020)", which selected a group of pilot county-level hospitals. The reform enhanced rural residents' accessibility to quality healthcare resources by increasing the allocation of healthcare resources and improving the capacity of hospital healthcare services. It provided a preferable policy environment for this study to identify the impact of healthcare resource allocation on patients' healthcare choices and to explore the underlying mechanisms.

The reform measures included the following: First, a comprehensive strengthening of the infrastructure of county-level hospitals, improvement of the departmental settings for diagnosis and treatment, and increased investment in hospital manpower, technology, and specialized departments. Second, a significant enhancement of the medical technology level of county-level hospitals, determining the weaker specialties in county-level hospitals based on the needs of residents in the county and factors such as the ranking of out-of-county hospital visits in recent years. Third, the continuous promotion of the construction of medical consortia within the county, driving the development of primary healthcare institutions, facilitating the sharing and decentralization of high-quality healthcare resources. The ultimate goal is to foster an orderly pattern of healthcare access and improve the efficiency of medical resource allocation within the county. The enhancement of comprehensive capabilities in county-level hospitals may attract patients back to local institutions, thereby reducing the rate of seeking healthcare outside the home county.

Models

Model

This study primarily investigates whether the enhancement of comprehensive capabilities in county-level hospitals has changed residents' healthcare choices, and simultaneously examines changes in residents' healthcare burdens and the quality of medical services. Therefore, based on the pilot policy of enhancing the comprehensive capabilities of county-level hospitals in the selected city, the pilot counties are designated as the treated group, while the non-pilot counties serve as the control group. A difference-in-differences model is constructed to estimate the policy's effects.

$$Y_{ijt} = \beta_0 + \beta_1 treat_{ij} * time_t + \beta_q X_{ijt} + \delta_i + \rho_t + \varepsilon_{ijt} \quad (1)$$

the dependent variable Y_{ijt} represents the outcome for patient i in county j at time$t$. These variables primarily include indicators such as whether the patient sought healthcare outside the county, inpatient expenses, and readmission rates. The determination of whether a patient sought healthcare outside the county is based on the patient's insurance registration location and the location where they received healthcare. If the patient treated within their insurance registered county, it is defined as seeking healthcare within the county, then$healthcarechoice = 0$. If the treatment place of the patient is not within their insurance registered county, it is defined as seeking healthcare outside the county, then$healthcarechoice = 1$. Inpatient expenses are calculated as the logarithm of the total hospitalization costs

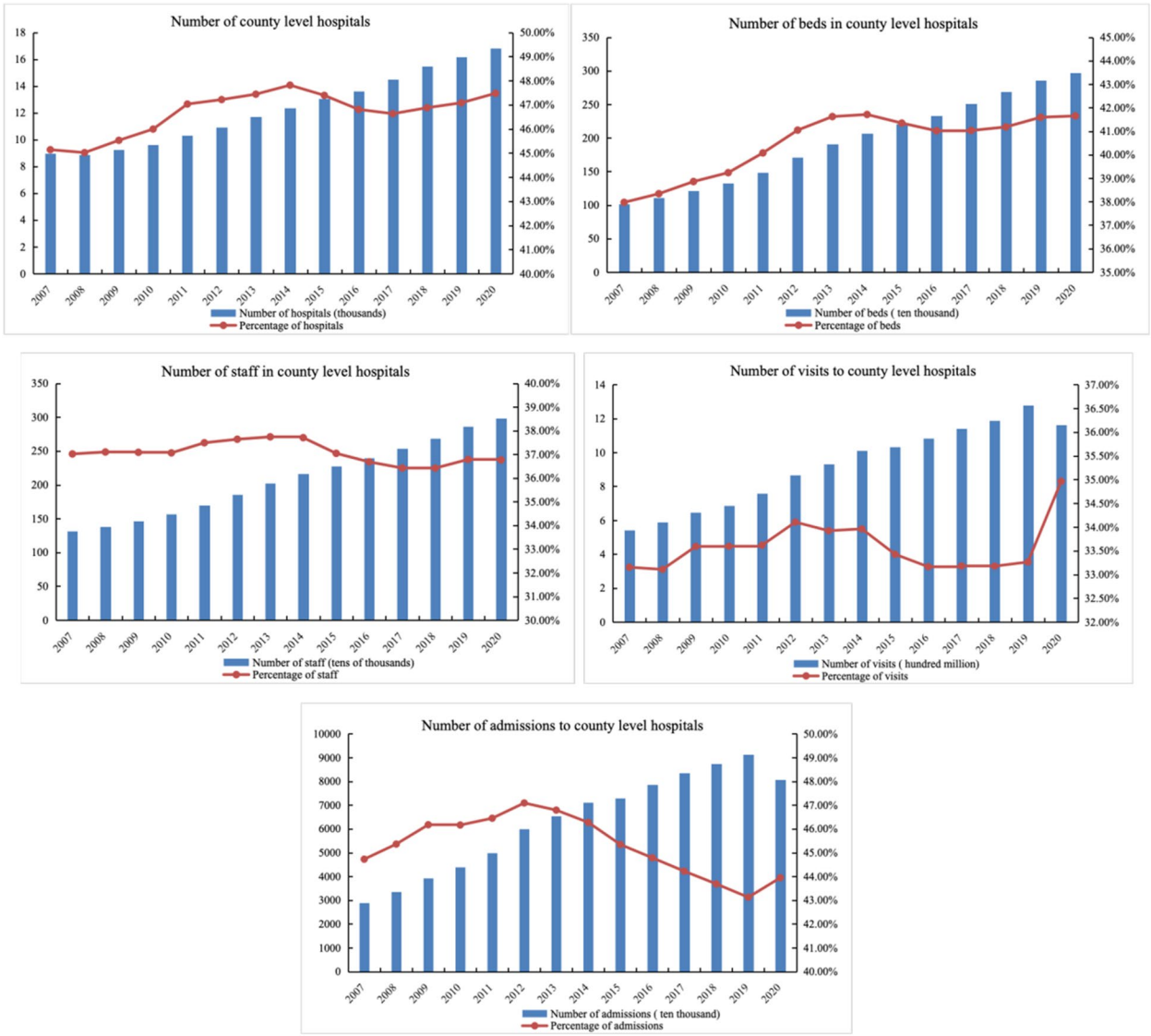

Fig. 1 Distribution of Healthcare Resources in County-Level Hospitals in China. Note: The data in Fig. 1 are compiled from the China Health Statistics Yearbook for previous years. Hospitals include general hospitals, Chinese medicine hospitals, combined Chinese and Western medicine hospitals, ethnic hospitals, specialist hospitals and nursing homes. The percentage indicators represent the ratio of county-level hospital indicators to the indicator for all hospitals

per patient. The readmission rate measures the proportion of patients who were readmitted for treatment with the same diagnosis (sharing the same three-digit ICD code). This rate includes readmission rates within two weeks, one month, and three months. The variable $treat_{ij}$ indicates whether a patient is in a pilot county. If the patient's place of insurance registration is within a pilot county, it is coded as $treat_{ij} = 1$; otherwise, it is coded as$treat_{ij} = 0$. In terms of timing variables, this study selects the time point of the publication of the pilot county list as the shock point. Therefore, the period before June 2019 is considered the pre-policy period ($time_t = 0$), and the period from June 2019 onwards is considered the post-policy implementation period ($time_t = 1$). Regarding control variables, this study controls for individual characteristics such as age, gender, and the three-digit ICD diagnosis. Additionally, it controls for county-level variables, including the number of beds per thousand people and the disposable income of rural residents. The study also includes individual fixed effects and year fixed effects in the analysis.

The reform explicitly states county-level hospitals should focus on diseases with high rates of patients seeking healthcare outside their county, based on the medical needs of residents within the county, and designate these diseases as priorities for county-level hospitals to improve. This involves increasing the allocation of healthcare resources to these areas. However, during the pilot reform process, significant changes occurred in hospital capacity, patient characteristics, disease distribution, and other factors. As a result, patient choices for healthcare are no longer exogenous in the assessment framework of this study; they are instead influenced by the reform itself. Therefore, this study starts by using data from 2018 to build a patient healthcare choice model based on whether patients seek healthcare within or outside their county. This model is then used to identify priorities diseases by predicting the probability of whether a patient would seek healthcare outside of the county.

$$out_i = \alpha_0 + \alpha_1 X_i + \epsilon_i \quad (2)$$

in Eq. (2), out_i represents whether a patient chooses to seek healthcare outside the county. If the patient goes outside the county, out_i equals 1; if the patient seeks healthcare within the county, out_i equals 0. The predictor variables, denoted as X, mainly include information such as inpatient expenses, age, gender, and disease diagnosis. This study uses data from 2018 as the foundational dataset to estimate the coefficients in Eq. (2). Based on these coefficients, the study predicts the probability of patients seeking healthcare outside their county in 2019 and 2020. Ultimately, using the actual percentage of seeking healthcare outside the county in this city (which is 16.3%), the study classifies patients. Patients with a predicted probability of seeking healthcare outside the county greater than 0.4 are identified as a priority disease for improvement in the county, and they account for 16.7% of the total sample.

Data

This study utilizes administrative data from the Basic Health Insurance for Urban and Rural Residents in a city in western China for the years 2018–2020. This city comprises 11 counties, with 4 counties designated as pilot counties. The dataset contains records of inpatient admissions for residents of all counties within the city during the sample period. It is a comprehensive dataset that accurately captures information related to residents' hospitalization behavior and inpatient expenses. The data includes the following key elements: (1) Patient Personal Characteristics: This includes information such as gender, age, and the district or county of insurance enrollment. (2) Hospitalization Information: Relevant hospitalization details include expenses, admission and discharge dates, disease diagnosis, disease diagnosis codes, hospitals, and hospital grades. (3) Additional Data Sources: To enrich the dataset, the study has matched economic information and healthcare resource data for various districts and counties. These additional data sources were obtained from the city's statistical yearbooks, the provincial government's data open platform, and other government websites. The use of this comprehensive dataset allows the study to conduct an in-depth analysis of the impact of county-level hospital capacity-building on residents' healthcare choices, medical expenditure burden, and healthcare quality over the specified period.

This study removed certain missing values and outliers. For instance, in the expenditure information, samples with single costs exceeding 50,000 yuan or below 100 yuan were excluded. Additionally, samples of elderly individuals over the age of 90 were removed. Since county-level hospitals mainly function as secondary hospitals, this study's benchmark regression analysis is limited to patients who received treatment in secondary hospitals, while focusing on diseases that have weak treatment capacity in the county. Table 1 provides descriptive statistics at the patient level. In the overall context of this

Table 1 Descriptive statistics of main variables

Variables	Observations	Mean	Standard Deviation	Min	Max
Proportion of seeking healthcare outside the county	69,465	0.163	0.371	0	1
Logarithm of Inpatient Expenses	69,465	8.885	0.933	4.605	10.820
Two-Week Readmission Rate	28,827	0.037	0.190	0	1
One-Month Readmission Rate	28,230	0.062	0.242	0	1
Three-Month Readmission Rate	27,142	0.082	0.274	0	1
Gender (Male = 1; Female = 0)	69,465	0.514	0.500	0	1
Age	69,465	42.099	22.046	0	80
Hospital Beds per Thousand People	69,465	6.057	1.889	5.690	8.070
Rural Residents' Per Capita Disposable Income (Thousand Yuan)	69,465	11.189	0.991	9.379	14.181

city, the mean rate of residents seeking healthcare outside their counties is 16.3%, slightly higher than the national average. This indicates that the level of county-level healthcare services in this region is relatively weak, and there is a significant outflow of patients. Regarding the gender and age structure of patients, the proportion of male inpatients is slightly higher than that of females, with an average age of 42.87 years. In terms of healthcare resources, this city has an average of 6.38 beds per thousand people, slightly lower than the national average of 6.46 beds in 2020. Rural residents have an average disposable income of 11,189 yuan, which is lower than the national rural resident per capita disposable income of 17,131 yuan in 2020.

Results

Benchmark regression results

The impact of optimizing the allocation of healthcare resources in county level hospitals on patients' choice of healthcare

Table 2 in the first column presents the impact of improving the comprehensive capabilities of county-level hospitals on patients' healthcare choices. The regression results show that, compared to non-pilot counties, patients in pilot counties significantly reduced their probability of seeking healthcare outside the county. This implies that, following improvements in rural healthcare resources, residents have gained more confidence in the availability and quality of healthcare services within their counties. As a result, more residents have chosen to seek healthcare within their counties. However, as indicated by the descriptive statistics, although this reform has increased the rate of residents seeking healthcare within their counties, there is still room for improvement in achieving the goal of "90% of residents seeking healthcare within the county" in various districts and counties of this city. The reasons for this may include the improvement in transportation convenience and policies such as direct reimbursement for inter-city medical expenses, which facilitates cross-district access for patients. Therefore, continuous efforts are needed in the future to further enhance the layout of high-quality healthcare resources in rural areas, improve residents' access to high-quality healthcare, and encourage patients to return to their counties.

The impact of enhancing the comprehensive capacity of county-level hospitals on patients' healthcare burden

Table 2, column (2), demonstrates the influence of enhancing the comprehensive capacity of county-level hospitals on the average inpatient expenses per patient. The regression results reveal that, compared to non-pilot

Table 2 The impact of improving the comprehensive capabilities of county-level hospitals on patients' healthcare choices and financial burden

Variables	(1) Healthcare Choice	(2) Healthcare Burden
Treat # post	−0.019**	−0.063***
	(0.007)	(0.020)
Post	−0.017***	−0.111***
	(0.005)	(0.013)
Age	−0.006**	0.028***
	(0.003)	(0.009)
Gender (Male = 1; Female = 0)	−0.076	0.199
	(0.062)	(0.169)
Hospital Beds per Thousand People	−0.002	0.000
	(0.002)	(0.004)
Rural Residents' Per Capita Disposable Income	0.073*	−0.543***
	(0.044)	(0.110)
Individual Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Three-Digit ICD Codes	Yes	Yes
Constant	0.186	12.504***
	(0.416)	(1.067)
Observations	69,465	69,465
R^2	0.812	0.686

Standard errors clustered at the department level are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. The following table is similar

counties, patients with potential demand for seeking healthcare outside their county experienced a significant reduction of 6.3% in their average inpatient expenses. This indicating that the enhancement of county-level hospital capacity significantly reduces the burden of inpatient expenses for patients. One possible explanation is that patients seeking healthcare services outside their county often opt for hospitals in urban areas, where medical equipment is better and healthcare resources are more abundant compared to county-level hospitals. This results in a heavier financial burden for patients. However, with the improved treatment capabilities of county-level hospitals, patients can effectively alleviate their financial burden by receiving medical care within their county. Furthermore, the study finds that inpatient expenses for patients increase significantly with age, aligning with existing literature. This could be attributed to older individuals having poorer physical health, leading to a higher utilization of healthcare resources compared to younger age groups.

Table 3 The impact of enhancing county-level hospital comprehensive capacity on healthcare quality

Variables	(1) Two-Week Readmission Rate	(2) One-Month Readmission Rate	(3) Three-Month Readmission Rate
Treat # Post	−0.036**	−0.033**	0.001
	(0.015)	(0.016)	(0.018)
Control Variables	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Three-Digit ICD Codes	Yes	Yes	Yes
Constant	0.125	0.483	1.947**
	(0.703)	(0.786)	(0.912)
Observations	28,827	28,230	27,142
R^2	0.423	0.417	0.408

Standard errors clustered at the department level are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

The impact of enhancing the comprehensive capacity of county-level hospitals on healthcare quality

The enhancement of county-level hospital comprehensive capacity aims to promote the allocation of high-quality healthcare resources to rural areas through hospital development, thereby providing high-quality medical services to residents within the county. Therefore, the assessment of healthcare quality is a crucial factor in evaluating the effectiveness of healthcare reform. To eliminate the influence of planned hospitalization behaviors, this study excluded patients with a hospitalization interval of less than 2 days between the next admission and the current discharge. To account for the effects of planned hospitalization behaviors, this study also excluded patients who had more than 3 hospitalizations within one year and removed patients with chronic and severe conditions that require regular hospitalization. The standard for measuring healthcare quality was based on non-planned hospitalizations within a specific period. The regression results are shown in Table 3, with columns (1) to (3) representing the two-week readmission rate, one-month readmission rate, and three-month readmission rate, respectively. The results indicate that, following the enhancement of comprehensive capacity in county-level hospitals, the healthcare quality of inpatients has significantly improved, as demonstrated by the reduction in readmission rates within two weeks and one month. However, the three-month readmission rate indicator is not statistically significant, suggesting that the quality of short-term hospital treatment has improved.

Based on the regression results from Tables 2 and 3, it can be observed that improving the allocation of healthcare resources in rural areas not only attracts patients to return for healthcare services within their county, creating an organized healthcare pattern but also enhances the efficiency of healthcare resource utilization. Simultaneously, it allows patients to enjoy better medical services while reducing the financial burden of inpatient expenses. This significantly improves the welfare of patients. Balancing the distribution of healthcare resources between urban and rural areas is an effective method to alleviate the challenges of limited access to medical care and high medical costs faced by rural residents in China.

Parallel trend and robustness tests

Parallel trend test

In this study, the pilot policy of improving the comprehensive capabilities of county-level hospitals is treated as a quasi-natural experiment. The policy effect is estimated using a difference-in-differences (DID) model. To ensure the comparability of the two groups of samples, it is essential to demonstrate that before the pilot, the pilot counties and non-pilot counties had the same trend of changes. We employed an event study approach to perform parallel trends tests, and the model setup is as follows:

$$Y_{ijt} = \alpha_0 + \sum_{p=-5}^{6} \alpha_0 treat_{ij} * quarter_t + \alpha_q X_{ijt} + \mu_t + \delta_i + \varepsilon_{ijt} \quad (3)$$

Here, $quarter_t$ represents the quarterly time variable, with the first quarter of 2018 as the base period, to observe how the policy effect changes over time. The remaining variables in Eq. (3) are set the same as in Eq. (1), where β_p is the coefficient of primary interest in this study. Figure 2. is constructed based on the estimated values of β_p and the confidence intervals. Overall, before the policy pilot, pilot counties and non-pilot counties generally exhibit a parallel trend. However, after the policy, the effect gradually becomes apparent. The rate of

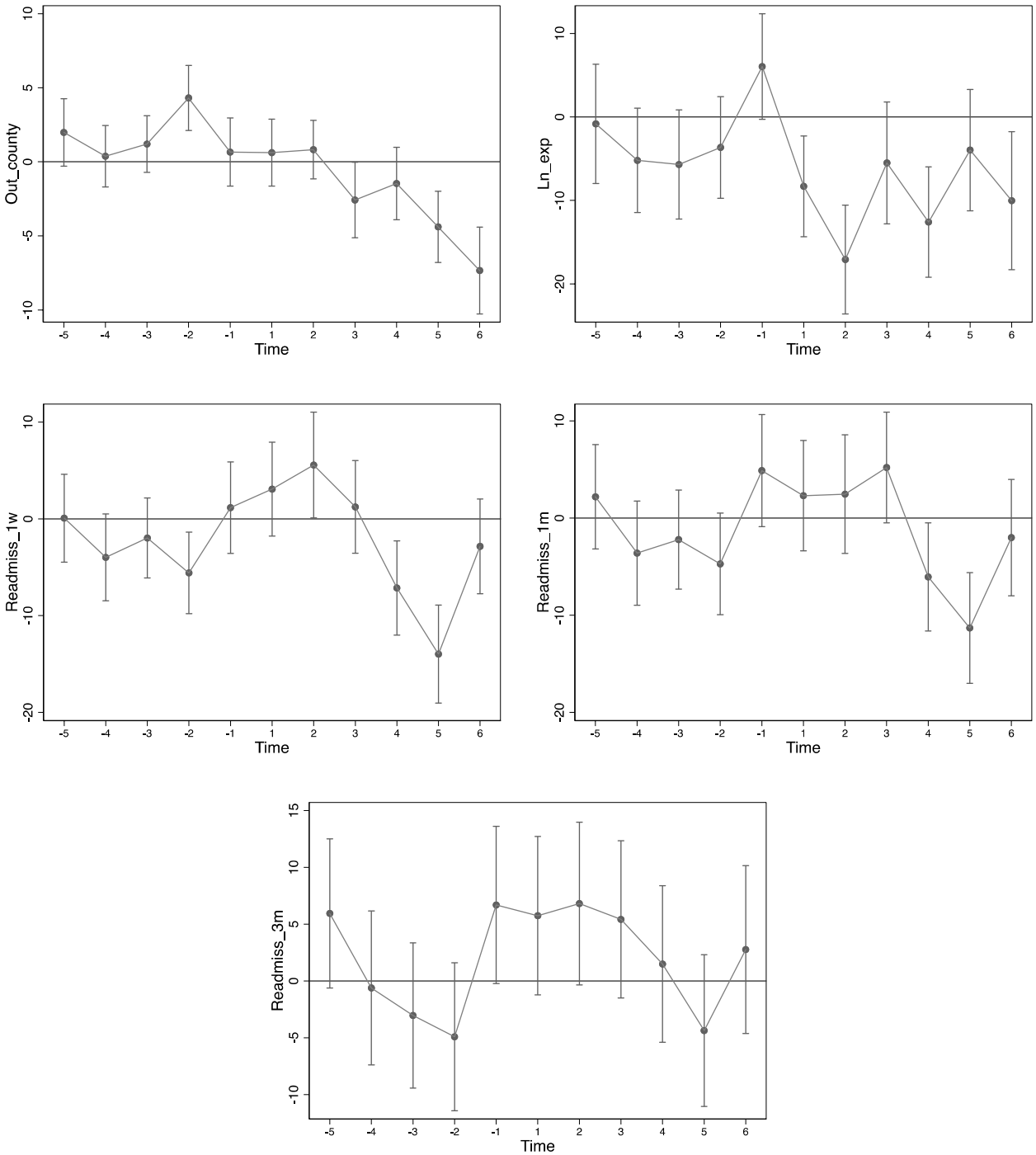

Fig. 2 Parallel Trends Test. Note: The horizontal axis represents the number of quarters before and after the announcement of the pilot list, where 1 corresponds to the third quarter of 2019, and −1 corresponds to the second quarter of 2019. The vertical axis represents estimated coefficients and their 95% confidence intervals

seeking healthcare outside the county decreases steadily, with a more pronounced decrease in 2020. This indicates that residents' confidence in local healthcare resources within the county has gradually accumulated. It also suggests that the enhancement of comprehensive capabilities of county-level hospitals has played a significant role in treatment during the epidemic period, meeting the basic medical needs of residents within the county. Regarding the trend in medical quality, it is observed that there is an overall improvement trend in medical quality within the county after the reform.

Robustness test

First, we need to rule out the impact of the COVID-19 pandemic. In January 2020, there was a global outbreak of COVID-19, which significantly affected residents' mobility and healthcare-seeking behaviors. During this period, most residents chose not to seek healthcare unless it was necessary, resulting in a sharp decline in outpatient and inpatient visits nationwide. This led to significant structural changes in patients' characteristics. Therefore, within the analytical framework of this study, the initial impact of the pandemic might have affected the regression results. As shown in Fig. 3, in February 2020, both the polit and non- polit counties experienced a dramatic decrease in the total number of monthly patients seen. However, this trend started to ease in March, with healthcare institutions gradually returning to normal patient volumes. To account for the impact of the pandemic-induced changes in medical demand on the regression results, we conducted robustness tests by excluding data from January to May 2020. The results, as shown in Table 4, remained robust.

Second, we need to rule out the impact of the poverty reduction policy. During the sample period analyzed in this study, the nation was actively engaged in the critical phase of poverty reduction, with some impoverished areas benefiting from policy support. Health support policies, as a vital component of precision poverty reduction, may have influenced residents' healthcare needs and the healthcare supply behavior of medical institutions, potentially interfering with the assessment of the policy's effectiveness in this study. Within this city, six counties were included in the national list of poverty-stricken counties. In September 2018, the city also introduced a health support program aimed at helping poverty-stricken counties in their efforts to reduce poverty. To eliminate the influence of the health poverty support program, this study excluded data from these six poverty-stricken counties and conducted robustness checks. As shown in Table 5, the regression results remained robust.

Mechanism analysis

The reform's work plan explicitly states that county-level hospitals should strengthen weak specialties. Based on the healthcare needs of residents within the county, the plan focuses on diseases with high rates of seeking healthcare outside the county in recent years. It aims to identify weak specialties and capacity gaps in county-level hospitals, striving to increase the rate of intra-county visits by residents to over 90%. It is evident that diseases with high rates of seeking healthcare outside the county will receive special attention and development in terms of corresponding departments in county-level hospitals. The effectiveness of improving the service capacity of these weaker

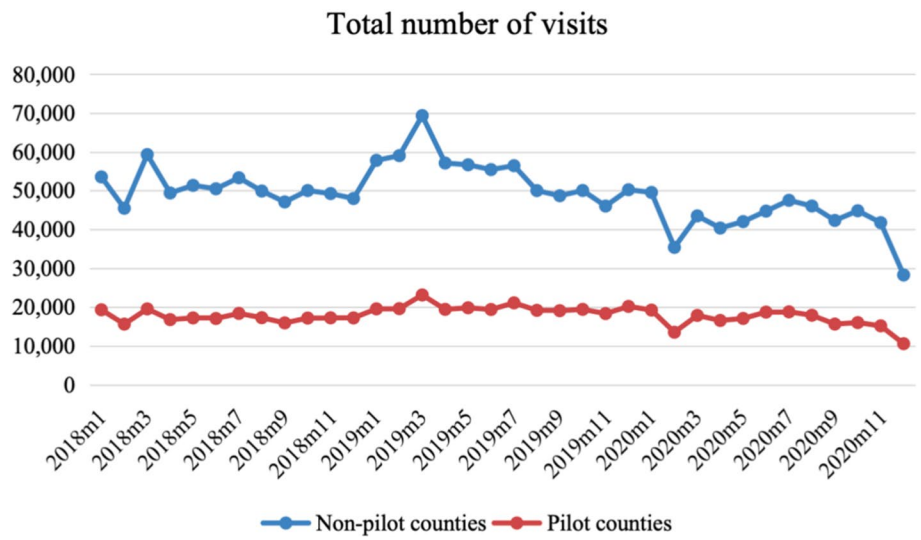

Fig. 3 Distribution of Patient Visits

Table 4 Excluding the impact of the covid-19 pandemic

Variables	(1) Healthcare Choice	(2) Healthcare Burden	(3) Two-Week Readmission Rate	(4) One-Month Readmission Rate	(5) Three-Month Readmission Rate
Treat # Post	−0.015*	−0.079***	−0.047***	−0.042**	−0.013
	(0.008)	(0.021)	(0.017)	(0.018)	(0.020)
Control Variables	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Three-Digit ICD Codes	Yes	Yes	Yes	Yes	Yes
Constant	0.150	13.175***	−0.289	0.136	1.528
	(0.457)	(1.187)	(0.785)	(0.858)	(1.004)
Observations	64,165	64,165	26,184	25,602	24,584
R^2	0.813	0.689	0.433	0.426	0.416

Standard errors clustered at the department level are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5 Excluding the impact of the poverty reduction policy

Variables	(1) Healthcare Choice	(2) Healthcare Burden	(3) Two-Week Readmission Rate	(4) One-Month Readmission Rate	(5) Three-Month Readmission Rate
Treat # Post	−0.019**	−0.088***	−0.035**	−0.030*	0.005
	(0.008)	(0.021)	(0.015)	(0.017)	(0.019)
Control Variables	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Three-Digit ICD Codes	Yes	Yes	Yes	Yes	Yes
Constant	−0.019	11.923***	0.069	0.446	1.631*
	(0.430)	(1.145)	(0.756)	(0.837)	(0.973)
Observations	53,173	53,173	21,620	21,172	20,371
R^2	0.803	0.684	0.431	0.424	0.416

Standard errors clustered at the department level are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

departments also needs further examination. Furthermore, this study distinguishes between common diseases and rare diseases based on the treatment focus of county-level hospitals. Rare diseases, on the other hand, include more severe conditions with relatively lower incidence rates, such as cancers and tumors. In accordance with China's classification of rare diseases, the study includes disease diagnoses from the sample that align with the rare disease classification into the rare disease group. All other disease diagnoses are categorized as common diseases.

Differences in healthcare choice among patient for different disease types

Table 6 presents the impact of the improvement in county-level hospital capacity on patients' choice of healthcare for different diseases. It is evident that after the reform, both the common disease and rare disease groups show a significant decrease in seeking healthcare outside the county. This may be attributed to the significant allocation of healthcare resources to weaker specialties during the capacity improvement of county-level hospitals. This has increased the accessibility of

Table 6 Differences in patients' choice of healthcare for different disease types

Variables	(1)	(2)	(3)	(4)
	Healthcare Choice		Healthcare Burden	
	Common Diseases	Rare Diseases	Common Diseases	Rare Diseases
Treat # Post	−0.032***	−0.035**	−0.102***	0.045
	(0.008)	(0.015)	(0.022)	(0.046)
Control Variables	Yes	Yes	Yes	Yes
Individual Fixed Effects	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Three-Digit ICD Codes	Yes	Yes	Yes	Yes
Constant	0.251	1.878**	10.353***	19.660***
	(0.492)	(0.747)	(1.401)	(2.256)
Observations	50,274	15,751	50,274	15,751
R^2	0.833	0.801	0.686	0.703

Standard errors clustered at the department level are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

high-quality healthcare resources for residents within the county. As a result, there is no need for them to travel to more distant cities for healthcare services, which significantly attracts residents to return for treatment within the county.

Differences in healthcare burden among patients with different disease types

Table 7, columns (3) to (4), displays the differences in average inpatient expenses for patients with different diseases. It shows a significant decrease in expenses for patients with common diseases in weaker specialties, while there is no significant change in the expense burden for patients with rare diseases in weaker specialties. This indicates that the enhancement of the reception capacity of county-level hospitals primarily reduces the expense burden for patients with common diseases, while its impact on the expense burden for patients with rare diseases is not significant. One possible reason for this pattern is that county-level hospitals are primarily tasked with treating common diseases. Therefore, during the development and allocation of healthcare resources in county-level hospitals, there is a significant focus on strengthening the treatment capabilities for common diseases. As a result, the reduction in expense burden is primarily observed among samples of patients with common diseases who seek treatment within the county. In fact, rare diseases have a lower incidence rate, a higher requirement for hospital treatment capabilities, and exhibit stronger economies of scale. Therefore, for the treatment of rare diseases, it is more optimal to increase the allocation of healthcare resources to tertiary hospitals in urban areas, resulting in a more efficient distribution of healthcare resources.

Table 7 Differences in changes in healthcare quality among patients with different disease types

Variables	(1)	(2)
	Common diseases	Rare diseases
Panel A Two-Week Readmission Rate		
Treat # Post	−0.036**	−0.019
	(0.017)	(0.032)
Observations	23,494	3,250
R^2	0.425	0.437
Panel B One-Month Readmission Rate		
Treat # Post	−0.029*	−0.018
	(0.017)	(0.045)
Observations	23,090	3,049
R^2	0.417	0.430
Panel C Three-Month Readmission Rate		
Treat # Post	0.001	0.055
	(0.020)	(0.076)
Observations	22,234	2,817
R^2	0.409	0.400
Control Variables		
Control Variables	Yes	Yes
Individual Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Three-Digit ICD Codes	Yes	Yes

Standard errors clustered at the department level are shown in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Differences in healthcare quality among patients with different disease types

Further analyzing the mechanism of changes in healthcare quality, Table 7 presents regression results using the readmission rates as indicators of healthcare quality. It shows that the quality of treatment for common diseases has significantly improved, while there hasn't been a significant improvement in the quality of treatment for rare diseases. This suggests that the improvement in healthcare resource allocation in rural areas have enabled patients who used to be referred to external facilities to now receive better-quality treatment within county-level hospitals. This has notably enhanced the accessibility and equity of high-quality healthcare resources for rural residents, leading to improved health outcomes. Furthermore, county-level hospitals have primarily allocated healthcare resources to the development of treatment capabilities for common diseases based on their regional positioning and resource endowment. Meanwhile, the treatment of rare diseases should largely rely on urban regional medical centers to leverage their economies of scale and promote the treatment capabilities for rare diseases.

Heterogeneity analysis

In this paper, we also analyze the heterogeneity of the different samples in terms of age and gender dimensions in order to explore the boundary conditions of the main results. Table 8 demonstrates the heterogeneity by age, where we categorize the sample into older and younger age groups using 60 years as the criterion. The results show that the policy has no significant effect on healthcare choice, Healthcare burden, and quality of care for the elderly, while there is a significant effect on the young, suggesting that the improvement of healthcare resources in rural areas has benefited the young more.

Table 9 shows the results of gender heterogeneity, and the results show that males are the winners in terms of quality healthcare resources sinking into the county, they return to the county, healthcare burden decreases, and the quality of healthcare improves significantly.

Discussion and conclusions

The equitable distribution of healthcare resources between urban and rural areas plays a crucial role in ensuring fair healthcare accessibility for residents and is a key priority for many countries. Strengthening the allocation of healthcare resources in rural areas is of significant importance in promoting the rational distribution of high-quality healthcare resources between urban and rural regions, thus enhancing the efficiency of medical resource allocation. Increasing investment in healthcare resources in rural areas is also a focal point of China's healthcare system reform. It aims to improve the accessibility and equity of high-quality medical services in rural areas by enhancing the capabilities of county-level hospitals. Chinese residents are highly sensitive to healthcare quality [38]. The reform of enhancing the comprehensive capabilities of county-level hospitals in rural areas aims to

Table 8 Heterogeneity analysis of age

Variables	(1) Healthcare Choice	(2) Healthcare Burden	(3) Two-Week Readmission Rate	(4) One-Month Readmission Rate	(5) Three-Month Readmission Rate
Panel A Elderly (age > = 60)					
Treat # Post	−0.013	0.002	−0.030	−0.015	−0.010
	(0.020)	(0.044)	(0.029)	(0.032)	(0.040)
Observations	15,633	15,633	6,365	6,199	5,962
R^2	0.798	0.759	0.444	0.431	0.415
Panel B Youngster (age < 60)					
Treat # Post	−0.016**	−0.081***	−0.044**	−0.040**	−0.006
	(0.008)	(0.022)	(0.018)	(0.019)	(0.021)
Observations	53,414	53,414	22,054	21,616	20,761
R^2	0.816	0.673	0.421	0.417	0.409
Control Variables					
Control Variables	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Three-Digit ICD Codes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the department level are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Table 9 Heterogeneity analysis of gender

Variables	(1) Healthcare Choice	(2) Healthcare Burden	(3) Two-Week Readmission Rate	(4) One-Month Readmission Rate	(5) Three-Month Readmission Rate
Panel A Male					
Treat # Post	−0.024**	−0.105***	−0.044**	−0.036	−0.001
	(0.009)	(0.027)	(0.022)	(0.023)	(0.026)
Observations	38,716	38,716	15,751	15,443	14,840
R^2	0.822	0.683	0.420	0.414	0.405
Panel B Female					
Treat # Post	−0.014	−0.010	−0.040*	−0.031	−0.001
	(0.012)	(0.030)	(0.021)	(0.023)	(0.028)
Observations	30,482	30,482	12,776	12,485	11,995
R^2	0.810	0.699	0.434	0.427	0.416
Control Variables					
Control Variables	Yes	Yes	Yes	Yes	Yes
County Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Three-Digit ICD Codes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the department level are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

improve the supply of high-quality healthcare resources, thereby influencing residents' choices of healthcare institutions. In recent years, with the improvement in transportation infrastructure, such as high-speed rail networks [33], and policy enhancements like direct billing for medical insurance across regions [6], a significant number of rural patients have been seeking treatment in large urban hospitals, leading to a continuous increase in the rate of seeking healthcare outside their home counties. The primary reasons for this trend include the rising income levels of rural residents and an improved awareness of healthcare needs, resulting in a growing demand for healthcare resources, especially high-quality healthcare services. However, there is a clear deficiency in the supply of high-quality healthcare resources in rural China, exacerbating the supply–demand imbalance. The enhancement of comprehensive capabilities in county-level hospitals, achieved through measures such as optimizing departmental arrangements and strengthening the healthcare workforce, serves as a critical means of meeting residents' healthcare needs. Consequently, it aims to improve residents' choices regarding healthcare facilities, attracting patients back to local healthcare institutions and reducing the rate of seeking healthcare outside the home county.

The structural imbalance in the allocation of healthcare resources reduces the efficiency of resource utilization, leading to issues of unfairness in healthcare resource utilization [36]. According to Shen and Du [28], a rational layout of healthcare resource allocation can guide residents to form an organized pattern of seeking medical care, improve the efficiency of healthcare resource utilization, enhance residents' accessibility to high-quality healthcare services, and curb the rapid growth of medical expenses. In China, primary healthcare institutions, especially in rural areas, have low service capabilities, resulting in a severe shortage of healthcare resources and service supply for rural residents. This has led to a serious problem of patients seeking healthcare in a disorderly manner, while also increasing the financial burden on patients for healthcare [21, 29]. We found that the enhancement of comprehensive capabilities in county-level hospitals can significantly reduce the patients' medical financial burden.

The primary goal of enhancing the comprehensive capabilities of county-level hospitals is to facilitate the distribution of high-quality healthcare resources to rural areas through targeted policy support. This initiative seeks to address gaps in healthcare services within counties by considering the regional distribution of healthcare resources and aligning them with the specific healthcare needs of residents. The overarching objective is to establish an efficient and high-quality healthcare service system. The work plan explicitly outlines the aim of elevating the service capabilities of

pilot county-level hospitals to the standards of tertiary hospitals. This will significantly enhance their capacity to deliver emergency care, as well as manage common diseases, prevalent illnesses, and critical conditions. Consequently, this pilot initiative will strengthen the triage and treatment capabilities of county-level hospitals, resulting in a marked improvement in the overall quality of healthcare services within counties.

This study reveals that increased investment in quality healthcare resources in rural areas significantly reduces residents' out-of-county visit rates, fosters a sustained return of patients to local facilities, and markedly lowers the burden of sub-average hospitalization costs. Additionally, care quality—measured by the two-week and one-month readmission rates—showed significant improvement. Further analysis of the underlying mechanisms indicates that the reform primarily enhanced the development of specialties addressing common diseases in county-level hospitals. This led to a substantial return of patients to these specialties, a notable reduction in their healthcare cost burdens, and a marked improvement in care quality. However, these effects were not observed in the specialties addressing rare diseases. County-level hospitals play a pivotal role in the allocation of urban and rural healthcare resources and are critical to improving the overall efficiency of medical resource distribution. Strengthening the comprehensive capabilities of county-level hospitals and increasing investments in high-quality healthcare resources in rural areas should be key priorities in the ongoing reform of China's healthcare system.

There are several limitations to our research. First, we used data from a single city for our empirical analysis, and although the city is well represented, we were unable to overcome the data limitations. Having access to nationwide data would have made the results of the analysis on this topic more meaningful. Second, China has taken many measures to improve rural healthcare resources, and we only analyzed the impact of the capacity improvement of county-level hospitals. Subsequently, China has also pursued policies such as paired assistance, and the analysis of these policies remains important for deepening the reform.

Authors' contribution

SZ led the study. He designed the study, led the data collection, analysis, and interpretation. YW and YC contributed to the study design, provided input into the data analysis, and wrote the first draft of the manuscript. MZ contributed to the study design, reviewed the manuscript, and helped the writing of the final draft manuscript. All authors reviewed and approved the final manuscript.

Funding

This paper was funded by the National Natural Science Foundation of China, "An Empirical Evaluation of the Level of Medical Expenditures at the End of Life and Their Economic Efficiency" (72273094). The Humanities and Social Science Fund of Ministry of Education of China, "Research on Compliance Identification and Intelligent Supervision Strategy of Medical Insurance Fund Expenditure Based on Machine Learning Methods", (23YJC790010). The Humanities and Social Science Fund of Ministry of Education of China, "Evaluation of the Welfare Effect of Outpatient Coordination and Policy Optimization Research", (23XJC790009). China Postdoctoral Science Foundation, "Early Warning of Disability Risk and Optimal Intervention Strategies for the Elderly Based on Medical Big Data and Machine Learning Methods", (2023M733204).

Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to the data confidentiality agreement, but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Not Applicable.

Competing interests

The authors declare no competing interests.

Received: 21 January 2025 Accepted: 16 March 2025
Published online: 31 March 2025

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