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The effect of health insurance reimbursement rates on middle-aged and elderly people's hospital choices: evidence from China

Biao Li[1], Xiang Liang[2] and Xiulin Qi[3*]

Abstract

Background Adjusting the health insurance reimbursement rate is essential to optimize the allocation of medical resources. This paper investigates the effect of health insurance reimbursement rates on middle-aged and elderly people's choice of hospitals in China.

Methods This study is conducted using the China Health and Retirement Longitudinal Study (CHARLS) database. This paper uses the widely used ordered logit model for estimation. We build three types of instrumental variables, Bartik instrumental variable, per capita financial income, and health risk perception bias, with the help of the propensity score matching method, aiming at the cleanest possible identification of causal relationship. Furthermore, we use a mediating effects model to investigate the specific mechanism by which the reimbursement rate influences patients' choice of hospitals.

Results Our findings reveal that the higher a hospital's reimbursement rate, the more likely a patient is to choose to seek care. This paper further calculates the marginal effects based on the benchmark regression. For every 1% increase in health insurance reimbursement rates, the probability of patients choosing primary hospitals decreases by 5.75%, choosing secondary hospitals decreases by 1.47%, and choosing tertiary hospitals increases by 7.22%. According to mechanistic analysis, this paper reveals for the first time that health signals from medical checkups significantly impact patients' health care choices. In addition, we discuss the heterogeneity of hospital choices by region, age, and health status.

Conclusions The results mean that when individuals are faced with a multitude of hospitals and are overwhelmed with choices, some small institutional designs can act as a nudge to help policymakers achieve a desirable outcome. The government should fully utilize health insurance's benefit adjustment role and implement a differentiated reimbursement strategy.

Keywords Health insurance, Reimbursement rate, Middle-aged and elderly people, Hospital choice

*Correspondence:
Xiulin Qi
qxl_econ@163.com
Full list of author information is available at the end of the article

Introduction

Medical and health care is closely related to the welfare of people's lives. The structural mismatch between health care resources and the demand for care has long been a challenge for governments worldwide [1]. The importance of health insurance systems is becoming increasingly recognized by countries in optimizing the allocation of health care resources. Health insurance can reduce the costs of health care services for its enrollees, thus closely related to the classic topic of individual medical choice behavior. The design of the reimbursement rates in the health insurance systems directly determines the patients' share of the medical costs. Considering the moral hazard, generous health insurance may cause patients to over-consume health care services and waste health care resources [2]. Worldwide, approximately 800 million people spend more than 10% of their total household budget on health care, and nearly 100 million fall into extreme poverty yearly due to health care costs.[1] As a result, many countries have tried to provide an appropriate level of insurance to control the growth of health care costs. However, in the few empirical studies on health insurance, there is little literature to answer how health insurance reimbursement rates affect people's choice of hospitals. This paper attempts to provide some evidence.

Health care demand behavior can generally be divided into two stages: whether to seek health care treatment and the choices of health care treatment. There is no doubt that primary care coverage increases the likelihood that people will seek care [3, 4]. Many useful attempts have been made by scholars to study the choices of medical treatment. The total cost of care is a measure of care choice that is commonly used in studies. It typically includes the costs of physician visits, hospitalization, prescription and over-the-counter drugs, and non-therapeutic costs [5–7]. Although it reflects the state of health care in general, it still does not distinguish between changes in the quantity and quality of health care services. This paper attempts to break away from traditional research ideas about health care demand behavior and begin with the internationally recognized effective institutional design of hierarchical medical system [8]. Internationally, the basic model of a hierarchical medical system is to classify hospitals based on disease priority and treatment difficulty. Different levels of health care hospitals are in charge of treating various levels of disease. Primary care will be provided in community clinics or health stations (known as primary hospitals), secondary care in township hospitals (known as secondary hospitals), and tertiary care in tertiary hospitals, according to the three-tier system. Specifically, chronic diseases with stable conditions, joint disorders, and frequently-occurring diseases are treated by lower-tier hospitals, while higher-tier hospitals mainly tackle acute diseases. According to data released by National Health Commission of the People's Republic of China, as of early 2019, 94.7% of China's prefecture-level cities have carried out hierarchical medical treatment pilots, and a relatively complete hierarchical medical system is taking shape.[2] In addition, most countries, including China, have given people relatively free access to health care choices to promote competition among hospitals. Patients can choose to go to different levels of hospitals based on their judgment. Therefore, this paper explores whether health insurance reimbursement rates affect people's choice of hospitals at different levels of care in a relatively lenient access environment.

China's important role as an integral part of the world's health care is gaining global attention. However, there are few empirical studies on health insurance and patients' choice of hospitals. This paper investigates the effect of health insurance reimbursement rates on middle-aged and older people's choice of hospitals using the China Health and Retirement Longitudinal Study (CHARLS) database. Considering that the group aged 45 and above is the high-risk group for health, research on this group will probably provide a theoretical reference to deal with the deepening aging problem and social security issues, including pension and medical care. This paper finds: first, patients are more likely to choose higher-tier hospitals when health insurance reimbursement rates are increased equally. Health insurance reimbursement alleviates the income constraint patients face and mainly releases patients' demand for quality health care resources. Second, there could be significant endogeneity issues when researching how health insurance affects hospital choices. In this paper, we construct three types of instrumental variables, Bartik instrumental variable, per capita financial income, and health risk perception bias, with the help of the propensity score matching method, aiming at the cleanest possible identification of causal relationships. Third, this paper reveals the specific mechanism by which reimbursement rates influence patients' choice of hospitals. Medical checkup plays a partially mediating effect on the influence of the reimbursement rates on the choice of hospitals. Higher health insurance reimbursement rates increase the probability

[1] World Health Organization and International Bank for Reconstruction and Development /The World Bank. Tracking universal health coverage: 2017 global monitoring report [R]. 2017.

[2] Data from National Health Commission of the People's Republic of China. See https://mo.mbd.baidu.com/r/XT0cIOHZYY?f=cp&u=299oc4571365e0ea

of medical checkups for patients, leading patients to choose higher-tier hospitals. Finally, the paper provides a detailed discussion of the heterogeneity of the impact of health insurance reimbursement rates across groups. This is not only of policy reference value for the construction of China's medical coverage system but also draws lessons for other developing countries.

Literature review

There are two major strands of literature pertinent to this study: one on the factors influencing health care demand behavior, and the other on the effect of health insurance on hospital choices.

The demand for health care services has been an important topic of health economics research, and the study of its influencing factors is of great significance for the sustainable development of health care [9]. On the demand side, a more comprehensive research perspective comes from Andersen's Model of Healthcare Utilization [10]. According to the model, the factors impacting patients' health care demand can be classified into three main categories: antecedent factors (gender, age, etc.), facilitators (family income, health care coverage, etc.), and demand factors (health status, etc.). Numerous studies have pointed out that gender, age, education level, health status, and family socioeconomic status can significantly affect the choices of health care [11–13]. On the supply side, quality of care, reputation, distance, and waiting time are important factors that influence patients' choices of health care [14, 15]. For example, studies have empirically examined the relationship between hospital quality and patient choice, noting that improving hospital quality of care contributes to improving social welfare and reducing inequality in patient health care utilization [16, 17]. In addition to the quality of care, a study based on a sample of 3,000 hospitals in the U.S. finds that hospital room environment and care delivery significantly influence patients' decisions to seek care [18]. Furthermore, when choosing hospitals, patients consider both quality and waiting time, and those who are willing to wait longer are more likely to seek high-quality care [19].

Another strand of literature is on the impact of health insurance on patients' choice of hospitals. The impact of health insurance on patients' health care behavior has been well documented. The expansion of health insurance coverage can substantially increase the accessibility of health care services to patients. Patients will respond to the costs of health care services under the role of health insurance and thus will seek different types of health care services [20, 21]. During the implementation of universal health insurance coverage in China, a large number of studies on the utilization of health care services by health insurance have also emerged [22–24]. These studies have generally found that enrollment can increase health care utilization. Yet the question that has been overlooked is whether the demand for health care services and welfare status within enrollees will also change as a result of some health insurance system designs. Studying the policy effects of changes in system design is important for improving health care policy. The answer to this important question remains inadequate, as existing research on health insurance and health care choices has been limited to the extent of whether or not to enroll and the type of enrollment.

In summary, although widely discussed in the previous literature, the relationship between health insurance and health care choice still has some gaps. First, studies based on health care choice behavior have focused more on the impact of quality of care. Even when studies have considered the effects of health insurance interventions, their analytical thinking has been limited to traditional health care utilization models. The importance of the health insurance system as the foundation and mainstay of the health care delivery system deserves more extensive attention and discussion. Second, in the literature on the relationship between health insurance and health care choices, previous literature has compared the differences between different populations without health insurance and those with health insurance. Less attention has been paid to changes in health care choices among enrollees. We focus on the design of reimbursement rates in health insurance schemes and examine the impact of their changes on patients' choice of hospitals. Third, regarding the study of patients' choices of health care, the total costs of health care commonly used in previous studies do not truly reflect the degree of medical service utilization. This paper examines how patients choose among different levels of hospitals based on the unique context of China's hierarchical medical system.

Institutional background and theoretical analysis

Institutional background

As a system of integrated and shared benefits, health insurance was originally designed to relieve some of the financial burdens on residents and to promote access to health care. China started a new round of medical and health system reform in 2009. Over the past ten years, China has gradually achieved full coverage of three major health insurance schemes: basic health insurance

for urban workers, basic health insurance for urban residents, and new rural cooperative health insurance. Worldwide, 38% of the population lacks health care coverage, and at least half of the world's population lacks basic health care.[3] China, nevertheless, has built the world's largest universal basic health care coverage network in a relatively short period of time. By the end of 2020, the number of participants in China's basic health insurance has reached 1.36 billion, and the coverage rate has remained stable at over 95%.[4] However, in some sections of China, particularly in rural areas, there is still a relatively low level of health insurance. Chinese residents' health care services utilize an "inverted pyramid" pattern [25]. To improve the level of health insurance coverage, China has merged the new rural cooperative health insurance with the basic health insurance for urban residents since 2016 to establish a basic health insurance system for urban and rural residents. This reform alleviates the problem of inequality in basic health insurance. Despite the state's increased investment in health care policies, disparities in the ability to pay according to income levels may result in finance failing to reach the much-needed low-income population.

The hierarchical medical system originally originated in the United Kingdom in the first half of the twentieth century and mainly used a three-tier medical system. In the 1950s, the World Health Organization promoted hierarchical medical treatment, and many countries began to explore, practice, and form their unique medical service models. China began to explore hierarchical treatment during the planned economy. The government established a three-tier medical service network to form an orderly hierarchical treatment pattern and ensure the equalization of health care services. In 2011, the Chinese government promulgated a new standard for hospital grading, which provides a comprehensive assessment of hospital functions, facilities, and technology and divides them into three grades, with Grade 1 being the lowest and Grade 3 being the highest. Generally speaking, primary hospitals are mainly village clinics in rural areas and community health service stations, secondary hospitals are mainly township health centers and community health service centers, and tertiary hospitals are mainly hospitals at the county level and above. By early 2017, four municipalities directly under the central government and 266 prefecture-level cities in China have launched hierarchical medical treatment pilots, accounting for 88.1% of all Chinese cities.[5] Tertiary hospitals are primarily responsible for treating acute and serious illnesses. Secondary hospitals, on the other hand, are in charge of treating common and multiple disorders, as well as receiving patients in recovery or stable stages referred by tertiary hospitals. Medical institutions of the primary and lower levels focus on providing treatment, rehabilitation, and care services for patients with precise diagnoses and stable conditions while also managing chronic diseases, such as hypertension and diabetes. In fact, China transitioned from a planned economy to a socialist market economy in the 1990s. Aside from that, the health insurance system for residents underwent disintegration and reconstruction. As a result, Chinese people were stuck in self-paying health care for a long time. They gradually formed relatively fixed health care habits. Based on this unique context, this paper investigates the allocation effect of health care resources at different levels of hospitals from the perspective of health insurance reimbursement rates. It is expected to provide new empirical evidence and policy references for optimizing the design of health insurance policies to promote the construction of the hierarchical medical system.

Theoretical analysis

The effect of health insurance reimbursement rates on patients' hospital choices

As a particular commodity, the market determination mechanism of health care is necessarily different from the general market of goods and services [26]. The unique characteristics of the health care market are evident in two aspects: first, information asymmetry. Information asymmetry exists in almost any market because the information held by both sides of the transaction is inconsistent. The medical market is highly asymmetric information and heterogeneous [27]. The health care market has a high technological barrier, and patients need more information about health care services, which significantly reduces their bargaining power. As a result, doctors often have more information and bargaining power in the health care market [28]. Because of the significant information asymmetry between doctors and patients, purchasing health care services is extremely risky and uncertain [29]. Second, irreversibility. Health care services cannot be tried and tested compared to general goods and services. Once medical consumers receive health care services, they must endure the repercussions of the therapy. Patients prefer to choose the finest and safest treatment when they become ill to avoid missing

[3] International Labour Organization. World Social Protection Report 2017–19; Universal social protection to achieve the Sustainable Development Goals [R]. 2017.

[4] Data from the National Healthcare Security Administration of the People's Republic of China. See http://www.nhsa.gov.cn/art/2021/3/8/art_7_4590.html

[5] Data from the National Health Commission of the People's Republic of China. See http://www.nhc.gov.cn/yzygj/s3593g/201608/7d264b533a3b403cb8348d40cfb9a9d3.shtml

the ideal period for treatment or suffering catastrophic effects from incorrect treatment. Due to the information asymmetry in the medical market, it is difficult for patients to have complete information about the disease independently. They can only make judgments by relying on the "signal effect" of the hierarchical medical system [30–33].

Everyone who suffers from an illness wishes to get the best care at the lowest possible costs. Health insurance reimbursement rates guide patients' choice of hospitals by changing their cost-sharing. In general, the higher the reimbursement rates, the lower the patients' out-of-pocket percentage. The difference in the amount of health care demanded by patients can be interpreted as a choice of different levels of hospitals. Health insurance reimbursement reduces the burden of medical costs on patients, releasing a portion of medical demand that was previously suppressed due to income constraints [34]. Based on the above analysis, we propose the following hypothesis.

> H1: With the increase in health insurance reimbursement rates, patients are more inclined to choose higher-tier hospitals.

Medical checkups can influence a patient's decision to seek health care. Medical checkups are performed to detect the presence of disease risks so that they can be prevented and treated promptly. Routine checkups are the most common way for people to detect probable disorders in their bodies, especially in the case of chronic diseases [35]. Pre-existing chronic disease issues are challenging to detect. However, the results of medical checkups can provide information about the population's health, allowing them to identify health concerns and make medical decisions earlier. The situation of chronic diseases among Chinese residents is not optimistic. *The Report on the Status of Nutrition and Chronic Diseases in China (2020)*, reveals that chronic diseases among Chinese residents are on the rise.[6] Chronic diseases accounted for 88.5% of all fatalities in China in 2019, and the disease burden caused by chronic diseases accounted for 70%. Medical checkups allow residents to know their health conditions promptly so minor diseases can be treated early and major diseases can be detected early. Scholars have examined data related to medical checkups and health care costs and have demonstrated a significant association between medical checkups and demand for health care services [36, 37].

The implementation of health insurance will increase the demand for preventive health care services such as medical checkups. Take China's New Rural Cooperative Medical System (NRCMS) as an example. China has set up a special fund for farmers' health checkups since 2006, which is used for the health checkups of NRCMS-insured farmers. With the advent of the NRCMS, the likelihood of farmers participating in medical checkups has grown, allowing many farmers with low sensitivity to medical care to discover potential ailments early and seek medical treatment promptly. The internal fear of disease, which originates from the agony of the treatment process and the high medical costs, is a major reason for not engaging in medical checkups. Health insurance reimbursement can partially share the patients' medical costs, eliminating the worry of medical checkups. Accordingly, we propose the following hypothesis.

> H2: Higher health insurance reimbursement rates increase the probability of medical checkups for patients, leading patients to choose higher-tier hospitals.

Heterogeneity of health insurance reimbursement rates affecting patients' hospital choices

There may be disparities in the impact of health insurance reimbursement on patients' choice of hospitals between urban and rural areas. Since 1949, the Chinese government has gradually built separate health insurance systems in rural and urban areas. Because of the uneven and insufficient regional development between urban and rural areas, there will always be disparities in China's health care resources. The urban medical system has been developed and enhanced to a larger extent since the reform and open-up policy in 1978. On the other hand, health care resources are constantly concentrated upward and cannot be sunk. In lower-tier hospitals, issues such as inadequate facilities and a lack of technical expertise have become more prominent. As a result, the health care needs of rural Chinese residents have long been suppressed [38]. Rural residents with low incomes and weak ability to pay often forgo seeking treatment at higher-tier hospitals. This phenomenon is even more severe considering the urban–rural gap in the distribution of wealth among Chinese residents [39]. In summary, rural residents need more release of health care needs than urban residents, and they are more sensitive to health care costs. Therefore, the increase in health insurance reimbursement rates mainly alleviates the constraints rural residents face. Accordingly, we propose the following hypothesis.

[6] Data from the National Health Commission of the People's Republic of China. See http://sc.people.com.cn/n2/2020/1224/c345459-34491982.html

H3: The increase in health insurance reimbursement rates has a more significant impact on the probability of choosing higher-tier hospitals for rural residents.

China has entered an aging society, and the demand for geriatric health care services cannot be underestimated. The health status of middle-aged and older people tends to deteriorate with age, and the elderly are more likely to be seriously ill and have a greater need for health care services [40]. Unlike common illnesses such as colds and fevers, diseases encountered by the elderly often require treatment at higher-tier hospitals. Data show that nearly half of Chinese people aged 60 and older suffer from chronic diseases such as hypertension.[7] The elderly are also prone to severe illnesses, putting a strain on health care facilities. As a high-risk population for health care, there is a need for supplemental health insurance measures for the elderly to meet their needs. In contrast, the reality of health care resource rationing puts the elderly in a disadvantaged position [41]. For a family, its health care resources tend to be skewed toward the household's youthful workforce, and it is more common for the elderly to forego treatment when they are seriously ill [23]. Thus, the elderly are more sensitive to changes of cost-sharing of health care services than other age groups. Accordingly, we propose the following hypothesis.

H4: For people over 60, a rise in health insurance reimbursement rates has a more significant impact on the probability of choosing higher-tier hospitals.

According to Andersen's Model of Healthcare Utilization, the health status of the population influences health care demand behavior [10]. Equal needs ought to be treated equally, and such needs are often closely tied to the health condition. On the one hand, those in poor health are more likely to become seriously ill and require specialist treatment, and they prefer higher-ranked hospitals. On the other hand, studies on health care equity have revealed that there is a "pro-rich" health gap, in which those with higher incomes are in better health but have access to more health care resources [42]. It implies that people in better health, although they have a relatively smaller need for health care services, will likewise prefer higher-tier hospitals. Lower-tier hospitals are regarded as the primary rehabilitation hospitals for patients with chronic diseases under China's hierarchical medical system to relieve strain on higher-tier hospitals. However, primary care actually tends to be underutilized, while higher-tier hospitals in China are overcrowded, resulting in inefficient allocation of resources. In addition, patients with chronic diseases bear a heavy medical burden for a long time, and they are more sensitive to medical costs under income constraints [43, 44]. Therefore, when health insurance reimbursement can alleviate part of the health care costs burden, patients with chronic diseases are more likely to choose to go to higher-tier hospitals considering their needs. Based on the above analysis, we propose the following hypotheses.

H5: Health status has a significant differentiating effect on patients' choice of hospitals.

H6: An increase in health insurance reimbursement rates has a more significant effect on the probability of choosing higher-tier hospitals for patients with chronic diseases.

Materials and methods

Data sources

The primary data used in this study are from the China Health and Retirement Longitudinal Study (CHARLS). The CHARLS intends to collect a high-quality, nationally representative sample of Chinese residents aged 45 and up to support the need for scientific research on the elderly. The project is directed by the National School of Development at Peking University, which has completed four rounds of national baseline surveys in 2011, 2013, 2015, and 2018. It covers about 10,000 households and 17,500 individuals in 150 counties/districts and 450 villages/resident committees, with sound sample representativeness. Data on demographic information, personal and household income, personal health status and functioning, and health care and insurance are primarily used in this paper. It is worth noting that CHARLS 2020 was recently released. However, it missed the Health Care and Insurance module, which made it difficult to implement our research. We select the four waves of national baseline surveys in 2011, 2013, 2015, and 2018 consisting of unbalanced panel data. The study population of this paper is Chinese middle-aged and older people aged 45 years and above, so the tiny amount of data under 45 years included in the sample is excluded. After further eliminating the observations with missing or abnormal key variables, the final sample size is 9344.

Variables definition

The dependent variable is the hospital level (Hospital). We examine which level of hospitals patients have chosen based on the patients' actual medical behavior in the past month. The CHARLS questionnaire asks respondents, "What type of medical facility did you last visit in the past month?". The hospital types are divided into three levels, combining the division of China's hospital system and the hierarchical medical system. Primary hospitals include village clinics/private clinics and health service

[7] Data from the State Council Information Office of the People's Republic of China. See http://www.scio.gov.cn/XWFBH/xwbfbh/wqfbh/2012/1226/xgxwfbh/Document/1261298/1261298.htm

Table 1 Variable description and descriptive statistics

Variables	Definition	Mean	Standard deviation	Minimum	Maximum
Dependent variable					
Hospital	Primary hospitals (1), secondary hospitals (2), tertiary hospitals (3)	2.294	0.828	1	3
Independent variable					
Rate	Reimbursement rates	0.252	0.325	0	1
Control variables					
Age	Age of respondents	68.478	9.950	45	100
Male	Yes (1), no (0)	0.442	0.497	0	1
Education	Years of education	5.249	4.203	0	19
Urban	Yes (1), no (0)	0.401	0.490	0	1
Health	Very healthy (1), relatively healthy (2), average (3), relatively unhealthy (4), very unhealthy (5)	3.656	0.958	1	5
Disease	Yes (1), no (0)	0.712	0.453	0	1
Income	Log income	7.701	2.764	0	13.850
Living	High (1), poor (0)	0.536	0.499	0	1

stations. Secondary hospitals include township health centers and community health service centers. Tertiary hospitals include Chinese medicine hospitals, specialty hospitals (excluding Chinese medicine hospitals), and general hospitals (excluding Chinese medicine hospitals). Primary, secondary, and tertiary hospitals are assigned 1, 2, and 3, respectively.

The independent variable is the health insurance reimbursement rates (Rate), measured by patients' average actual health insurance reimbursement rates. The reason for using this indicator is that the policy design of the Chinese health insurance system, such as the starting and capping lines and some out-of-pocket items, makes the actual reimbursement rates of patients inconsistent with the reimbursement rates of hospitals at all levels specified in the policy. The patients' health care choices will be based on practical information about previous reimbursement rates rather than the reimbursement rates set by the policy. The CHARLS asks participants about their visits to outpatient clinics or therapy received in the previous month (excluding hospitalization) and hospitalization received in the previous year. The overall medical costs for the patients included both out-of-pocket and reimbursement components. The patients' average actual health care reimbursement rates are the ratios of the reimbursed share to the total costs.

The control variables are classified into three groups: demographic variables (gender, age, years of education, and type of residence); health status (self-rated health and presence of chronic diseases); and household socioeconomic status (per capita household income and household living standards). The specific variables are defined as follows: (1) Age is an important factor influencing the choice of hospitals. Age is introduced as a control variable in this paper, and the actual age of respondents at the time of the interview is estimated using information from CHARLS on their year of birth (Age). (2) In this research, gender is used as a control variable, with males (Male) allocated to 1 and females (Female) assigned to 0. (3) Education level affects the choice of hospitals (Education). In this paper, the years of education are selected as the control variable. Combined with the Chinese education system, illiteracy is assigned a value of 0, incomplete elementary school is assigned a value of 3, private school and elementary school graduation are both assigned a value of 6, junior high school graduation is assigned a value of 9, high school or secondary school is assigned a value of 12, and college, bachelor's degree, and master's degree are assigned a value of 15, 16, and 19, respectively. (4) Considering the urban–rural dichotomy of Chinese society, we also control for the type of residence by assigning a value of 1 to individuals living in urban areas and 0 to those living in rural areas (Urban). (5) Many researchers have indicated that health status impacts health care choices [45]. The respondent's health status self-assessment is utilized as a metric (Health). It is divided into five categories: very good, good, fair, bad, and very bad, with values assigned as 1, 2, 3, 4, and 5, respectively. (6) The presence or absence of chronic disease also influences the choice of health care hospitals (Disease). The CHARLS survey covers 14 different chronic diseases: hypertension, dyslipidemia, diabetes, cancer or malignant tumor, chronic lung diseases, liver disease, heart attack, stroke, kidney disease, stomach or other digestive diseases, psychiatric problems, memory-related disease, arthritis or rheumatism, and asthma.

(7) The family's socioeconomic status influences the choice of hospitals. We introduce income level (Income) as a control variable. (8) To further control the household socioeconomic position, we introduce household living levels (Living). Individuals with very high, relatively high, or average living standards are assigned a value of 1, while those with lower living standards are awarded 0. In the regressions below, we also control for province-fixed effects and further control for time-fixed effects in the full sample regressions. The specific assignment and statistical description of the variables are shown in Table 1.

Regarding gender distribution among respondents who visited hospitals in the previous month, there are 44.2% of men and 55.8% of women overall, with a higher percentage of women. In terms of age distribution, the average age of the patients is approximately 68 years old, better representing the middle-aged and older population. The average number of years of education is about 5.2 years in terms of education. The proportion of the urban population in the sample is 40.1%, while the proportion of the rural population is 59.9%. In terms of health status, the mean value of a self-assessed health score is 3.656, which is between "average" and "relatively unhealthy". 71.2% are afflicted with chronic diseases. In terms of per capita household income, the mean log of that figure is 7.7. 53.6% of respondents perceive their household living conditions to be satisfactory in terms of living conditions. The average reimbursement rate for medical costs is 25.2%. Regarding patients' choice of hospitals, 23.9% choose primary hospitals, 22.8% choose secondary hospitals, and 53.3% choose tertiary hospitals. The majority of participants choose tertiary hospitals, and there is a difference in this proportion between urban and rural areas.

From the data in Table 2, it can be seen that there is a significant urban–rural difference in residents' choice of hospitals. Among urban residents, 16.2% choose primary hospitals, 19.9% choose secondary hospitals, and 63.9% choose tertiary hospitals. The attendance rate of tertiary hospitals in urban areas is much higher than that of lower-tier hospitals. Among rural residents, 29.1% choose primary hospitals, 24.6% choose secondary hospitals, and 46.3% choose tertiary hospitals. The rate of tertiary hospital visits in rural areas is lower than that of urban residents. This shows that lower-tier hospitals in cities are underutilized, while higher-tier hospitals carry a heavy burden of medical supply.

Table 2 Distribution of hospital choices (%)

Hospital	Total	Urban	Rural
Primary hospitals	23.9	16.2	29.1
Secondary hospitals	22.8	19.9	24.6
Tertiary hospitals	53.3	63.9	46.3

Model settings

The dependent variables in this paper are ordinal data, at which point OLS (ordinary least squares) estimation would no longer be applicable. Therefore, this paper uses the widely used ordered logit model for estimation. To examine the effect of health insurance reimbursement rates on the choice of hospitals for the middle-aged and older, the basic model is set as follows.

$$Hospital_i = \alpha + \beta Rate_i + \gamma X_i + \varepsilon_i \quad (1)$$

where $Hospital_i$ represents the level of hospitals chosen by the patients and can be taken as 1, 2, or 3. $Rate_i$ represents the average actual health insurance reimbursement rates of patients. X_i are the control variables. ε_i is the random disturbance term with the independent identical distribution.

Considering the potential endogeneity issue in estimating model (1), we apply the instrumental variables method to address this concern. This approach helps mitigate the bias caused by endogeneity, ensuring more consistent and reliable estimates. The following outlines the estimation procedure:

$$Rate_i = a + bZ_i + cX_i + \varepsilon_i \quad (2)$$

$$Hospital_i = \varphi_0 + \varphi_1 \hat{Rate}_i + \varphi_2 X_i + \nu_i \quad (3)$$

where Z_i is an instrumental variable that should theoretically be highly correlated with health insurance reimbursement rates, but not with people's choice of hospitals. Both ε_i and ν_i are randomly perturbed terms, and $Cov(\varepsilon_i, \nu_i) \neq 0$.

We construct a counterfactual inference model using the propensity score matching method (PSM) to reduce the impact of the presence of unobservable variables on the accuracy of the parameter estimates. Depending on whether the treatment variable is discrete or continuous, there are two methods: the propensity score matching method (PSM) and the generalized propensity score matching method (GPSM). Although the GPSM relaxes PSM's constraint that the treatment variables must be binary discrete variables, it requires the outcome variables to be continuous variables. The treatment variable in this paper is the rate of health insurance reimbursement for middle-aged and older people, a continuous variable, but the outcome variable is the level of hospitals chosen by the patients, a discrete variable. Therefore, this paper uses the propensity score matching method and transforms the continuous variable of reimbursement rates into a binary discrete variable. Specifically, samples with reimbursement rates below the mean are assigned a value of 0, representing the low reimbursement rates group. Samples with reimbursement rates at or above the mean

are assigned a value of 1, representing the high reimbursement rates group. Given the sample characteristics X_i, the conditional probability of the reimbursement rates for the middle-aged and older is as follows:

$$P(X_i) = \Pr[D_i = 1|X_i] = \frac{\exp(\lambda X_i)}{1 + \exp(\lambda X_i)} \quad (4)$$

where $D_i=1$ denotes a group with high reimbursement rates (treatment group), while $D_i=0$ denotes a group with low reimbursement rates (control group). X_i represents the characteristic variables (matching variables) that may affect the actual health insurance reimbursement rates, and we still choose the control group variables in the baseline regression model as matching variables. λ is the coefficient corresponding to each influence factor. We estimate the propensity score value by Eq. (4). In this paper, three methods of nearest neighbor matching, kernel matching, and radius matching are used for estimation to assure the robustness of the matching results.

The average treatment effect on the Treated group (ATT) is then calculated as follows:

$$ATT = E(y_{1i} - y_{0i}|D_i = 1) = E(y_{1i}|D_i = 1) - E(y_{0i}|D_i = 1) \quad (5)$$

Empirical results

Benchmark regression results

The regression results of model (1) are reported in Table 3. Columns (1) to (4) show the sub-sample regression results for the data of 2011, 2013, 2015, and 2018, respectively. Column (5) shows the full-sample regression results for the four years of data. As can be seen from the table, the estimated coefficients of $Rate_i$ are all positive and significant at the 1% level, indicating that as the reimbursement rates of health insurance increase, patients are more likely to visit higher-tier hospitals. The regression results adequately validate H1.

The regression results of the control group variables show that gender, education, type of residence, health status, income level, and standard of living all influence patients' choice of hospitals. Specifically, the coefficient for Male is significantly positive, indicating that male patients are more likely to choose higher-tier hospitals. The more educated people are, the more likely they choose higher-tier hospitals. Urban residents have significantly higher access to higher-tier hospitals than rural residents. The poorer the health status, the more people tend to choose higher-tier hospitals. This may be due to the high risk of disease and the increasing need for health care for people with poor health status. Income affects patients' choice of health care hospitals, with higher income leading to higher levels of hospital choices. People with higher household living levels are more likely to choose higher-tier hospitals. In addition, age and chronic diseases also influence health care choices, which we will explore further below.

Table 3 Benchmark regression results

Variables	Hospital				
	2011	2013	2015	2018	Full sample
	(1)	(2)	(3)	(4)	(5)
Rate	0.4887*** (0.0659)	0.3108*** (0.0479)	0.4510*** (0.0371)	0.1503*** (0.0385)	0.3331*** (0.0217)
Age	-0.0136** (0.0065)	-0.0008 (0.0061)	0.0088** (0.0043)	0.0142*** (0.0045)	0.0062** (0.0025)
Male	0.2433** (0.1156)	0.0570 (0.1093)	0.1694** (0.0787)	0.0312 (0.0822)	0.1196*** (0.0456)
Education	0.0507*** (0.0159)	0.0475*** (0.0151)	0.0373*** (0.0102)	0.0505*** (0.0111)	0.0460*** (0.0061)
Urban	0.4621*** (0.1185)	0.6104*** (0.1095)	0.4147*** (0.0829)	0.5113*** (0.0878)	0.4945*** (0.0477)
Health	0.0389 (0.0611)	0.0331 (0.0572)	0.1291*** (0.0403)	0.0822* (0.0435)	0.0781*** (0.0237)
Disease	0.0482 (0.1409)	0.1345 (0.1201)	-0.1837* (0.0162)	0.2124*** (0.0766)	0.0584 (0.0497)
Income	0.0113 (0.0201)	0.0087 (0.0194)	0.0189 (0.0162)	0.0414*** (0.0149)	0.0193** (0.0083)
Living	0.0814 (0.1073)	0.2607*** (0.1042)	0.3113*** (0.0731)	0.0227 (0.0764)	0.1750*** (0.0425)
Province	Yes	Yes	Yes	Yes	Yes
Year	No	No	No	No	Yes
Observations	1488	1574	3219	3063	9344

1) Heteroskedasticity-Robust Standard Errors are reported in parentheses; 2) ***, **, * refer to 1%, 5%, and 10% statistical significance levels, respectively

Instrumental variables regression results

There may be endogeneity problems in the baseline regressions, which may lead to biased estimation results. There are two sources of endogeneity: first, unobservable patient characteristics that simultaneously influence hospital choices and actual health insurance reimbursement rates. More medically concerned families, for example, are more likely to have higher insurance coverage and, as a result, receive higher reimbursement rates. At the same time, patients with high awareness of household medical care are more likely to visit higher-tier hospitals. Since household medical awareness is difficult to observe, this variable's omission will lead to biased estimation results. Second, the reverse causality between the health insurance reimbursement rates and the choice of hospitals for the middle-aged and older. For example, due to the biased setting of China's health insurance reimbursement policy, patients who seek care at higher-tier hospitals tend to receive only lower reimbursement rates, which leads to biased estimates.

Based on the above analysis, this paper uses the instrumental variables method to deal with the endogeneity problems. The following instrumental variables are constructed in this paper.

Considering the possible reverse causality problem in model estimation, the "Bartik instrument" is constructed by referring to Bartik [46]. Specifically, the predicted value of the individual reimbursement rates is measured by combining the initial reimbursement costs structure and the general trend of the national reimbursement rates growth during the sample period [47, 48].

$$Bartik_{i,t}=ReimShare_{i,t_0} * (1 + RateGrow_t) \tag{6}$$

where $ReimShare_{i,t_0}$ indicates the rate of patient reimbursement costs for the base period to total national reimbursement costs. $RateGrow_t$ represents the national growth rate of health insurance reimbursement rates. The reasonableness is that the general trend of national growth in reimbursement rates must be closely related to individual reimbursement rates. At the same time, the predicted value does not directly affect individual health care choices because it represents the general trend of national growth. The weak instrumental variable test results show that the F value is 44, and no weak instrumental variable problem exists. The regression result based on the instrumental variables approach in Column (1) of Table 5 shows that after accounting for endogeneity, the patient reimbursement rates still significantly influence hospital choices, indicating that the above regression findings are robust and reliable.

The second instrumental variable is the per capita financial income of each prefecture-level city in China (Finance). The rationale for choosing this instrument variable is that, on the one hand, public finance shares a portion of health care inputs. Hence, local revenue has a crucial impact on health insurance reimbursement rates. A solid local fiscal position can provide adequate social security for residents. Higher fiscal revenue means higher health care investment, thus higher health insurance investment and correspondingly higher reimbursement rates. On the other hand, local fiscal revenue is not directly related to residents' choice of hospitals [49]. Two-stage least-squares method is used for estimation. The one-stage regression results indicate that the F-value of 15 is greater than 10, meaning no weak instrumental variable problem. Column (2) of Table 5 reports the results of the instrumental variable regression, and the estimated coefficient of the reimbursement rates remains significantly positive after dealing with the endogeneity problem. It suggests that as the actual health insurance reimbursement rates increase, middle-aged and older people are more likely to choose higher-tier hospitals. Therefore, our baseline regression results are robust.

The third instrumental variable is health risk perception bias (Bias). Individuals are unable to accurately assess health risks due to limitations in cognitive ability, external factors, etc. This will lead to a bias between the subjective perception of health risk and the objective status of health risk, which we refer to as health risk perception bias [50]. In terms of metrics, health risk subjective perceptions (HRS) are normalized to a range of 0–1 using the self-assessment of health status from the CHARLS questionnaire. 0 indicates the greatest health risk and 1 the least. We refer to the Quality of Well-being Scale (QWB) constructed by Kaplan and Anderson [51] to measure the objective status of health risks. The objective health risk score is calculated by ranking and weighting the indicators of MOD, PAC and SAC, and CPX. The QWB is assigned a value between 0 and 1, with 0 indicating the greatest health risk and 1 the least. The specific index settings and weights of the QWB scale are shown in Table 4.

$$QWB = 1 + MOD + PAC + SAC + CPX \tag{7}$$

In this paper, we refer to Riddel and Hales [52] and quantify the health risk perception bias as the logarithm of the ratio of the subjective health risk perception (HRS) to the objective health risk condition (QWB). Bias > 0 indicates blind optimism bias, i.e., the subjective health risk perception is less than the objective health risk condition. Bias < 0 indicates blind pessimism bias, i.e., subjective perception of health risk is greater than the objective health risk. Bias = 0 indicates no bias.

$$Bias_i = \log(\frac{HRS_i}{QWB_i}) \tag{8}$$

Health risk perception bias is highly correlated with health insurance reimbursement rates. First, health insurance reimbursement can reduce patients' disease losses and improve their health risk expectations. Second, due to the ex-ante moral hazard in health care, patients' motivation to prevent disease decreases when they are insured. As a result, patients increase their unhealthy behavior, which deteriorates their objective health status. In addition, there is no other theoretical mechanism by which health risk perception bias affects patients' choice of hospitals. The F-value of 108 indicates that the instrumental variable satisfies the assumption of correlation with the endogenous variable and that there is no weak instrumental variable problem. Column (3) of Table 5 reports the results of the instrumental variable estimation. The estimated coefficient of the reimbursement rates remains significantly positive after dealing with the endogeneity issue, confirming the robustness of our baseline regression results.

Table 4 Indicator settings and weights of the QWB scale

Indicator categories		Indicator definition	Weight
Mobility Scale (MOB)	MOB1	No limitations for health reasons	-0.000
	MOB2	Not driving, riding in a car, or taking public transportation for health reasons (or needing help)	-0.062
	MOB3	In hospital, health related	-0.090
Physical Activity Scale (PAC)	PAC1	No limitations for health reasons	-0.000
	PAC2	Wheelchair-bound (self-controlled), have difficulty (or cannot attempt) to lift weights, bend, stoop, go upstairs and hills for health reasons, use crutches or other aids or have other physical limitations in walking for health reasons	-0.060
	PAC3	In a wheelchair (no control by self), mostly in bed/chair/sofa	-0.077
Social Activity Scale (SAC)	SAC1	No limitations for health reasons	-0.000
	SAC2	Limited in other (e.g., recreational) role activity, health related	-0.061
	SAC3	Limited in major (primary) role activity, health related	-0.061
	SAC4	Perform no major role activity, health related, but do perform self-care activities	-0.061
	SAC5	Perform no major role activity, health related, and do not perform or have more help than usual in performance of one or more self-care activities, health related	-0.106
Symptom/Problem Complexes (CPX)	There are 23 categories of CPX, and the specific indicators and weights are detailed in Table 2 of Kaplan and Anderson (1988)		

Table 5 Instrumental variables regression results

Variables	Instrumental variables		
	Bartik	Finance	Bias
	(1)	(2)	(3)
Rate	0.3878***	0.9294***	0.9376***
	(0.0210)	(0.3026)	(0.1093)
Age	-0.0030***	-0.0129**	-0.0129***
	(0.0011)	(0.0057)	(0.0026)
Male	0.0339*	-0.0008	-0.0352
	(0.0184)	(0.0311)	(0.0291)
Education	0.0122***	0.0035	0.0041
	(0.0024)	(0.0058)	(0.0040)
Urban	0.1310***	0.0116	0.0038
	(0.0200)	(0.0712)	(0.0387)
Health	0.0093	-0.0282	-0.0291
	(0.0097)	(0.0247)	(0.0189)
Disease	0.0178	0.0126	0.0170
	(0.0201)	(0.0270)	(0.0290)
Income	0.0033	-0.0032	-0.0003
	(0.0035)	(0.0058)	(0.0055)
Living	0.0627***	0.0522**	0.0298
	(0.0173)	(0.0236)	(0.0262)
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Observations	9344	9344	7306

1) Heteroskedasticity-Robust Standard Errors are reported in parentheses; 2) ***, **, * refer to 1%, 5%, and 10% statistical significance levels, respectively

Marginal effect analysis

Since the meaning of the parameters of the ordered Logit model is not intuitive, it is not possible to account for the specific effect of health insurance reimbursement rates on patients' choice of hospitals. Therefore, calculation of marginal effects is required. We further calculate how the probability of the dependent variable taking each value changes for each unit change in the independent variable when all independent variables are at the mean [53]. The calculation formula is as follows:

$$\frac{\partial \Pr(y=i|x)}{\partial x}|_{x=\bar{x}}(i=1,2,3) \tag{9}$$

The results are shown in Table 6. Only the results of the marginal effect analysis for the full sample are presented here, and the marginal effects for the four years of data are calculated similarly. When all independent variables are at their mean values, the meaning of marginal effects is as follows. For every 1% increase in health insurance reimbursement rates, the probability of patients choosing primary hospitals decreases by 5.75%, choosing secondary hospitals decreases by 1.47%, and choosing tertiary hospitals increases by 7.22%. Therefore, with an equal rise in health insurance reimbursement rates, patients are more likely to choose tertiary hospitals. These results further validate H1.

Table 6 Results of marginal effect analysis

Variables	Primary hospitals	Secondary hospitals	Tertiary hospitals
Rate	-0.0575*** (0.0038)	-0.0147*** (0.0009)	0.0722*** (0.0045)
Age	-0.0011** (0.0004)	-0.0003** (0.0001)	0.0013** (0.0005)
Male	-0.0206*** (0.0079)	-0.0053*** (0.0020)	0.0259*** (0.0099)
Education	-0.0079*** (0.0011)	-0.0020*** (0.0003)	0.0100*** (0.0013)
Urban	-0.0853*** (0.0082)	-0.0218*** (0.0022)	0.1071*** (0.0101)
Health	-0.0135*** (0.0041)	-0.0034*** (0.0011)	0.0169*** (0.0051)
Disease	-0.0101 (0.0086)	-0.0026 (0.0022)	0.0126 (0.0108)
Income	-0.0033** (0.0014)	-0.0009** (0.0004)	0.0042** (0.0018)
Living	-0.0302*** (0.0073)	-0.0077*** (0.0018)	0.0379*** (0.0092)

1) Delta-method Standard Errors are reported in parentheses; 2) ***, and ** refer to 1% and 5% statistical significance levels, respectively

Propensity score matching method regression results

The balance test between the treatment and control groups is shown in Table 7 after the nearest neighbor matching method is used. This paper examines the balance of matching in two ways: first, the mean value. As shown by the T-test and P-value, there are significant differences in age, gender, education, type of residence, health status, chronic disease prevalence, income level, and standard of living between the treatment and control groups before matching, and these differences are primarily eliminated after matching. Second, the standardized deviation. It is generally considered that its ideal absolute value should be less than 20%. According to Table 7, the absolute values of standardized deviations of all variables after matching are below 2%, which satisfies the judgment criteria. Therefore, our propensity score matching is reasonable and practical.

To ensure the robustness of the estimation results, three methods of nearest neighbor matching, kernel matching, and radius matching are used for estimation in this paper. Among them, the bandwidth used for kernel matching is 0.06, and the radius for radius matching is set to 0.05. Table 8 reports the total regression results. As shown by the estimation results, the results obtained by the three matching methods are close, indicating that our conclusions are robust and that the health insurance reimbursement rates substantially impact people's hospital choices.

Robustness test results

To further verify the robustness of the above findings, we replace the measure of the dependent variable $Hospital_i$ in model (1). Respondents are asked about their hospitalization in the previous year in the CHARLS questionnaire question "What is the type of health or service facility which you visited for your most recent hospitalization in the past year?". We assess the patients' hospital choices based on the patients' hospital levels at the most recent hospitalization in the previous year. The hospital

Table 7 Balance test

Variables	Match type	Mean		Bias (%)	T-test	
		Treated	Control		T-value	*P*-value
Age	Before	0.4793	0.4048	15.0	7.14	0.000
	After	0.4787	0.4834	-0.9	-0.41	0.684
Male	Before	71.2850	68.7470	27.9	13.27	0.000
	After	71.2610	71.3580	-1.1	-0.45	0.654
Education	Before	5.3308	4.8446	11.7	5.54	0.000
	After	5.3215	5.2873	0.8	0.35	0.726
Urban	Before	0.4280	0.3301	20.3	9.66	0.000
	After	0.4274	0.4215	1.2	0.52	0.606
Health	Before	3.8053	3.6590	15.6	7.41	0.000
	After	3.8048	3.8026	0.2	0.10	0.920
Disease	Before	0.7588	0.7249	7.7	3.66	0.000
	After	0.7588	0.7531	1.3	0.57	0.568
Income	Before	7.8046	7.5741	8.9	4.19	0.000
	After	7.8012	7.7703	1.2	0.52	0.603
Living	Before	0.5505	0.5256	5.0	2.36	0.018
	After	0.5500	0.5552	-1.0	-0.45	0.650

Table 8 Propensity score matching method regression results

	Neighbor	Kernel	Radius
ATT	0.3290*** (0.0185)	0.3272*** (0.0174)	0.3281*** (0.0173)
Observations	9344	9344	9344

1) ATT: the average treatment effect on the Treated group; 2) Standard Errors are reported in parentheses; 3) *** refers to 1% statistical significance level

classification is consistent with the baseline regression, with values of 1, 2, and 3 assigned to primary, secondary, and tertiary hospitals. The results are shown in Table 9, and the regression results are generally consistent with the baseline regression. The results indicate that the findings above are robust.

Mechanism analysis

We use a mediating effects model to investigate the specific mechanism by which the reimbursement rates influence patients' choice of hospitals.

$$Hospital_i = \alpha + \beta_1 Rate_i + \gamma_1 X_i + \varepsilon_i \quad (10)$$

Table 9 Robustness test results

Variables	Hospital				
	2011	2013	2015	2018	Full sample
	(1)	(2)	(3)	(4)	(5)
Rate	0.5486*** (0.0669)	0.4387*** (0.0508)	0.5278*** (0.0392)	0.1861*** (0.0401)	0.4081*** (0.0229)
Age	-0.0124* (0.0065)	0.0026 (0.0063)	0.0110** (0.0044)	0.0172*** (0.0046)	0.0083*** (0.0025)
Male	0.2296** (0.1155)	0.1079 (0.1130)	0.1150 (0.0803)	-0.0320 (0.0859)	0.0891* (0.0469)
Education	0.0491*** (0.0157)	0.0433*** (0.0153)	0.0390*** (0.0104)	0.0479*** (0.0115)	0.0444*** (0.0062)
Urban	0.4467*** (0.1182)	0.6039*** (0.1138)	0.4594*** (0.0856)	0.5846*** (0.0914)	0.5284*** (0.0491)
Health	0.0491 (0.0611)	0.0827 (0.0585)	0.1583*** (0.0414)	0.1519*** (0.0448)	0.1205*** (0.0243)
Disease	0.1210 (0.1401)	0.1565 (0.1247)	-0.0988 (0.1037)	0.2386*** (0.0790)	0.1010** (0.0511)
Income	0.0008 (0.0198)	0.0054 (0.0204)	0.0146* (0.0165)	0.0362** (0.0151)	0.0137 (0.0085)
Living	0.0532 (0.1069)	0.2199** (0.1063)	0.2296*** (0.0750)	0.1105 (0.0785)	0.1649*** (0.0434)
Province	Yes	Yes	Yes	Yes	Yes
Year	No	No	No	No	Yes
Observations	1488	1574	3219	3068	9349

1) Heteroskedasticity-Robust Standard Errors are reported in parentheses; 2) ***, **, * refer to 1%, 5%, and 10% statistical significance levels, respectively

Table 10 Results of mechanism analysis

Variables	Hospital (1)	Intermediary (2)	Hospital (3)
Rate	0.3331*** (0.0217)	0.1774*** (0.0236)	0.3238*** (0.0218)
Checkup			0.2802*** (0.0431)
Age	0.0062** (0.0025)	0.0296*** (0.0027)	0.0042* (0.0025)
Male	0.1196*** (0.0456)	-0.1444*** (0.0484)	0.1286*** (0.0457)
Education	0.0460*** (0.0061)	0.0495*** (0.0064)	0.0431*** (0.0062)
Urban	0.4945*** (0.0477)	0.3288*** (0.0505)	0.4745*** (0.0479)
Health	0.0781*** (0.0237)	0.0303 (0.0246)	0.0757*** (0.0237)
Disease	0.0584 (0.0497)	0.1505*** (0.0517)	0.0494 (0.0497)
Income	0.0193** (0.0083)	0.0534*** (0.0089)	0.0162* (0.0084)
Living	0.1750*** (0.0425)	0.0337 (0.0449)	0.1723*** (0.0425)
Province	Yes	Yes	Yes
Year	Yes	Yes	Yes
Observations	9344	9344	9344

1) Heteroskedasticity-Robust Standard Errors are reported in parentheses; 2) ***, **, * refer to 1%, 5%, and 10% statistical significance levels, respectively

$$Intermediary_i = \varphi + \beta_2 Rate_i + \gamma_2 X_i + \varepsilon_i \quad (11)$$

$$Hospital_i = \delta + \beta_3 Rate_i + \beta_4 Intermediary_i + \gamma_3 X_i + \varepsilon_i \quad (12)$$

where $Intermediary_i$ is the mediating variable. According to the above analysis, the increase in the reimbursement rates of health insurance can increase the probability of residents participating in medical checkups. Whether or not to take a medical checkup is an essential factor influencing residents' choice of hospitals. Therefore, this paper uses "medical checkups or not" as a mediating variable (Checkup). According to the CHARLS, residents are asked to answer: "When did you take the last physical examination in the last two years?". We assign a value of 0 to patients who didn't ever take medical checkups yet and those who didn't take medical checkups last two years, and a value of 1 to those who had attended a medical checkup in the past two years. Equation (10) aims to see if there is a substantial effect of the health insurance reimbursement rates on residents' choice of hospitals. Equation (11) examines whether the health insurance reimbursement rates substantially impact the probability of residents having medical checkups. Equation (12) explores whether there is a significant effect of

both health insurance reimbursement rates and medical checkups on residents' hospital choices.

Table 10 reports the results of the mechanical test. Column (1) in Table 10 is consistent with the baseline regression results in Column (5) of Table 3, indicating a significant effect of health insurance reimbursement rates on patients' choice of hospitals. The regression results after the inclusion of the mediating variable are reported in Column (2) and Column (3) of Table 10. The results in Column (2) indicate that the increase in the reimbursement rates significantly increases the probability of patients participating in the medical checkups. β_1, β_2, and β_3 are all significantly positive, indicating that medical checkups have a mediating effect on the reimbursement rates and residents' choice of hospitals. Column (3) incorporates "Checkup" into the model, and β_3 is still significantly positive. It implies that medical checkup plays a partially mediating effect in the influence of the reimbursement rates on the choice of hospitals. The above analysis well verifies H2.

Heterogeneity analysis

From the descriptive statistical results and benchmark regressions, it is clear that there are urban–rural differences in the utilization of health care resources among Chinese residents. While urban residents have access to higher quality health care resources, there is an inequality of opportunity in the utilization of health care services between urban and rural residents. This means that there are also urban–rural differences in the impact of health insurance reimbursement rates [6]. Therefore, it is necessary to discuss the urban–rural differences in hospital choices further. Column (1) and Column (2) of Table 11 report the regression results for the urban and rural subgroups. The results indicate that the increase in reimbursement rates tends to make both urban and rural residents choose higher-tier hospitals. The coefficient of reimbursement rates is more prominent for rural residents than for urban, indicating that each unit increase in reimbursement rates has a more significant effect on the probability of choosing higher-tier hospitals for rural residents. The results confirm H3. It should be noted that the population aged 60 and above in rural China accounts for 23.81% of the total rural population in 2020, nearly 8 percentage points higher than that in urban areas. According to the projections of China National Committee on Aging, the proportion of people aged 60 and above in China's rural areas will rise to 37.7% of the rural population by 2035.[8] Our findings have important implications for coping with the high level of aging in rural areas. Age can impact patient health care utilization [54]. We further divide the middle-aged and older populations into two age groups, 45–60 years old and over 60 years old, and then run the regressions separately. Column (3) and Column (4) of Table 11 report the regression results for the sub-group by age. The results show that when the reimbursement rates increase, the probability of choosing higher-tier hospitals is significantly higher for the over-60 group. This is associated with a greater demand for health care services among the elderly over 60. The results validate H4.

To further investigate the differentiation of health status on people's choice of hospitals, we divide the full sample into three subsamples representing "Healthy", "Average", and "Unhealthy" according to their health status. The results of the subgroup regressions for health status are reported in Table 12, Column (1), Column (2), and Column (3). The coefficients of Rate show that health insurance reimbursement has the most significant increase in the probability of choosing higher-tier hospitals for those who are unhealthy. Perhaps this is due to the reason that people with poorer health are more likely to be seriously ill and have greater demands for health

Table 11 Urban–rural and age group differences in the effect of reimbursement rates

Variables	Urban or Rural		Age	
	Urban	Rural	45–60 years old	Over 60 years old
	(1)	(2)	(3)	(4)
Rate	0.2847*** (0.0372)	0.3638*** (0.0270)	0.2002*** (0.0513)	0.3590*** (0.0239)
Age	0.0194*** (0.0043)	-0.0021 (0.0031)		
Male	-0.0391 (0.0776)	0.2454*** (0.0575)	-0.0430 (0.1037)	0.1589*** (0.0506)
Education	0.0787*** (0.0101)	0.0225*** (0.0079)	0.0547*** (0.0138)	0.0441*** (0.0068)
Urban			0.2382** (0.1050)	0.5500*** (0.0542)
Health	0.0835** (0.0412)	0.0816*** (0.0290)	0.0535 (0.0539)	0.0805*** (0.0265)
Disease	0.0844 (0.0859)	0.0314 (0.0612)	0.1585 (0.1027)	0.0295 (0.0574)
Income	0.0353** (0.0138)	0.0095 (0.0106)	0.0185 (0.0168)	0.0196** (0.0097)
Living	0.1570** (0.0759)	0.1760*** (0.0516)	-0.0207 (0.0948)	0.2177*** (0.0478)
Province	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
Observations	3453	5891	1872	7472

1) Heteroskedasticity-Robust Standard Errors are reported in parentheses; 2) ***, and ** refer to 1% and 5% statistical significance levels, respectively

[8] Data from the National Committee on Aging of the People's Republic of China. See https://news.cctv.com/2021/12/09/ARTImZdJRdCPx0S71P14mCMX211209.shtml

Table 12 Health status and disease differences in the effect of reimbursement rates

Variables	Health			Disease	
	Healthy	Average	Unhealthy	No	Yes
	(1)	(2)	(3)	(4)	(5)
Rate	0.3496*** (0.0786)	0.2275*** (0.0379)	0.3869*** (0.0282)	0.2934*** (0.0432)	0.3491*** (0.0252)
Age	0.0163* (0.0092)	0.0138*** (0.0044)	0.0001 (0.0032)	0.0124*** (0.0047)	0.0039 (0.0029)
Male	0.0422 (0.1731)	-0.0514 (0.0804)	0.2162*** (0.0594)	0.0935 (0.0916)	0.1276** (0.0530)
Education	0.0517** (0.0232)	0.0372*** (0.0107)	0.0496*** (0.0080)	0.0446*** (0.0116)	0.0458*** (0.0072)
Urban	0.5133*** (0.1810)	0.5285*** (0.0834)	0.4902*** (0.0627)	0.4707*** (0.0922)	0.5115*** (0.0561)
Health				0.0570 (0.0452)	0.0870*** (0.0280)
Disease	0.1638 (0.1645)	0.0451 (0.0798)	0.0417 (0.0707)		
Income	-0.0073 (0.0360)	0.0564*** (0.0151)	0.0058* (0.0107)	0.0140** (0.0168)	0.0219*** (0.0097)
Living	0.2212 (0.1637)	0.2586*** (0.0752)	0.1294** (0.0546)	0.1322 (0.0168)	0.1926*** (0.0496)
Province	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Observations	721	3024	5599	2443	6901

1) Heteroskedasticity-Robust Standard Errors are reported in parentheses; 2) ***, **, * refer to 1%, 5%, and 10% statistical significance levels, respectively

care. More interestingly, healthy residents also tend to choose higher-tier hospitals, possibly because they are more health-conscious, which validates H5. In addition, we perform group regressions based on the presence or absence of chronic diseases, with the results displayed in Table 12, Column (4), and Column (5). The findings show that patients with chronic diseases prefer higher-tier hospitals, which support H6.

Discussion

Results explanation

Health care has been widely studied because of its relevance to people's well-being. Among them, the health insurance system is both the foundation and the main body of the health care system. Previous literature has compared differences between populations without health insurance and those with health insurance, devoting less attention to changes in the demand for health care among enrollees. Of the few empirical studies on health insurance that focus more on the impact of reimbursement rates on health care utilization or health care costs, there needs to be more literature to answer how reimbursement rates affect people's choice of hospitals. This paper examines this issue using data from the China Health and Retirement Longitudinal Study (CHARLS) to fill this gap.

Our findings reveal that the higher the reimbursement rates, the more likely patients are to choose higher-tier hospitals. This is because the higher the reimbursement rate, the lower the patients' out-of-pocket percentage. Health insurance reimbursement reduces the burden of medical costs and releases patients' demand for quality medical resources. The difference in the amount of health care demanded by patients can be interpreted as a choice of different levels of hospitals. As a result, patients tend to prioritize tertiary hospitals when health insurance reimbursement rates are increased. Previous studies have also demonstrated that the design of health insurance policies has a significant impact on the healthcare utilization behavior of insured individuals. For example, studies using data from China have found that increasing the reimbursement rate promotes residents' demand for both outpatient and inpatient healthcare services [55]. Other studies have also highlighted the crucial role of health insurance in improving patients' access to medical services. For example, one study examined a policy change in Sweden, where copayments were eliminated for individuals aged 85 and above, to assess how patients dynamically respond to the impending reduction in out-of-pocket healthcare costs [56]. Another study used Medicaid data from the United States to assess the impact of changes in Medicaid costs on healthcare accessibility, utilization, and expenditures for Medicaid beneficiaries. The study found that increased primary care reimbursement for Medicaid beneficiaries leads to higher utilization and out-of-pocket spending for Medicaid enrollees [57]. This paper further calculates the marginal effects based on the benchmark regression. When all independent variables are at their mean values, the meaning of marginal effects is as follows. For every 1% increase in health insurance reimbursement rates, the probability of patients choosing primary hospitals decreases by 5.75%, choosing secondary hospitals decreases by 1.47%, and choosing tertiary hospitals increases by 7.22%. This result suggests that while a higher reimbursement rate improves healthcare access, further increases for those with basic needs already met may raise moral hazard [44]. These findings highlight the necessity of assessing moral hazard when analyzing the cost–benefit aspects of health insurance reforms [58].

This paper also finds that health signals from medical checkups significantly impact patients' health care choices. Medical checkups are the primary way to detect potential diseases in the body and an essential means of disease prevention [35, 59]. Disease prevention and therapy are two ongoing phases with a feedback-regulated

link. We incorporate this relationship into the analytical framework of this paper. This paper uses "medical checkup or not" as a mediating variable. The Chinese culture has an idiom of "Hiding One's Sickness for Fear of Treatment". This ancient tradition originated in ancient China during the Spring and Autumn Period and the Warring States Period with the story of the magpie who met the Duke of Cai Huan[9] Theoretical studies refer to this phenomenon of concealing illness and reluctance to seek medical treatment as information avoidance [60]. Some empirical evidence suggests that people tend to avoid important information about their health status, such as refusing to get checked or being informed of checkup results [61, 62]. The cost of medical examinations partially explains this phenomenon of information avoidance. Our study further finds that health insurance reimbursement alleviates the financial burden of medical expenses, increasing demand for preventive healthcare services such as health check-ups. Moreover, access to personal health information enables individuals to make more informed health decisions [63].

In addition, we discuss the heterogeneity of hospital choices by region, age, and health status. We find that the increase in health insurance reimbursement rates significantly affects the probability of choosing a higher-tier hospital for rural residents, the over-60 group, and the chronically ill group. This is mainly because rural residents and older people over 60 have long been disadvantaged in allocating health care resources [64]. The increasing reimbursement has resulted in a greater demand for their health care. The chronically ill suffer from the burden of disease for a long time and are more sensitive to changes in reimbursement levels [65]. Our study finds that the increase in reimbursement rates makes them more likely than the average patients to visit higher-tier hospitals. Finally, in the context of the differentiation of health status on patients' choice of hospitals, this paper explores some of the topics of equity in health care. Specifically, we group the populations by health status and find that those in better and worse health prefer higher-tier hospitals. This phenomenon opposes the view of health economics that equal needs ought to be treated equally. This could mean that there is "pro-rich" health inequality. People with higher incomes have better health but access to more health care resources [66].

Theoretical implications

One of the theoretical contributions of this paper is to add to the literature that explores the relationship between health insurance and hospital choices. As the cornerstone and mainstay of the health care system, the importance of health insurance deserves more thorough attention and discussion. However, in the few empirical studies on health insurance, there is little literature to answer how health insurance reimbursement rates affect patients' choice of hospitals. This paper attempts to provide some evidence. Second, this paper's discussion of the relationship between health insurance and hospital choices delves into the level of reimbursement within enrollees. This complements previous literature based on comparisons between different populations without health insurance and those with health insurance. Participation in insurance can increase health care utilization and health care costs. These studies do not address whether hospital choices and welfare levels among enrollees may vary due to particular health insurance system designs [67]. This paper answers this critical question. Third, this paper provides some novel perspectives on hospital choices. Previous studies commonly use the total costs of care to explore health care choices. Although it reflects the state of health care in general, it still does not distinguish between changes in the quantity and quality of health care services [68]. This paper attempts to depart from the traditional line of research on health care demand behavior. Starting from the hierarchical medical treatment, an internationally recognized and practical system design, we examine how the probability of patients choosing different levels of hospitals is affected by the reimbursement rates [8]. Fourth, at the methodological level, we also attempt to overcome the endogenous challenges traditionally faced in studying the impact of health insurance on hospital choices. To more appropriately examine the impact, we build a Bartik instrumental variable of the endogenous reimbursement rates. In addition, two more types of instrumental variables are built in this research, and the propensity score matching method is used to provide a cleaner identification of causality.

Practical implications

First, the findings of this paper have theoretical reference value for breaking the structural mismatch between medical resources and demand for health care. As the population's demand for quality medical resources increases in China's health care field, higher-tier hospitals are becoming very crowded [69]. Accordingly, medical equipment and human resources in lower-tier hospitals have become idle. We find that the higher a hospital's reimbursement rate, the more likely a patient is to choose to seek care. This means that when individuals are faced with a multitude of hospitals and are overwhelmed with choices, some small institutional designs can act as a nudge to help policymakers achieve

[9] Excerpted from "Han Feizi: Examples of Laozi's Philosophy", China Book Store, collected works of philosophers, 1954 edition.

a desirable outcome. The government should fully utilize health insurance's benefit adjustment role and implement a differentiated reimbursement strategy. Specifically, the government can consider appropriately increasing health insurance reimbursement rates for primary and secondary hospitals under the principle of guaranteeing relative equity and meeting most people's needs for medical treatment. In turn, it can guide patients to seek medical treatment in a reasonable and orderly manner and reduce the overcrowding of large hospitals. Second, the government should improve primary hospitals' service capacity and service quality and guide the sinking of high-quality medical resources. This paper finds that rural residents and older age groups over 60 are disadvantaged in allocating medical resources, and their health care needs have long been under-released. This result stems from the unbalanced development of China's urban and rural areas, where the construction of the rural medical system has long lagged behind that of the cities. Therefore, the Chinese government should invest more funds to strengthen medical coverage for vulnerable groups and improve primary hospitals' service capacity and quality. In addition, primary hospitals should be equipped to provide daily examinations, rehabilitation, and care services to patients with stable conditions and chronic diseases. This is because one of the goals of the hierarchical medical system is to keep chronic and common diseases in primary hospitals and share the treatment tasks of higher-tier hospitals. Finally, the discussion of the influence mechanism in this paper can serve as a foundation for improving and implementing policies related to medical checkups in health insurance. In *the Outline of the Healthy China 2030 Plan*, the Chinese government states that to promote the construction of a healthy China, prevention should be the main focus.[10] When determining particular reimbursement items and implementation methods, the health insurance system should fully recognize the function of medical checkup policies in encouraging the prevention of major diseases. The government should raise demands for preventative medical services such as medical checkups, as well as encourage people to identify health risks through medical checkups and seek timely health care.

Study limitations

This study has several limitations. First, while using data from the China Health and Retirement Longitudinal Study (CHARLS), our analysis primarily focuses on patients' choices among different hospital tiers. However, due to data availability constraints, alternative healthcare-seeking behaviors, such as purchasing medication from pharmacies, home-based care, or other substitute medical services, were not examined, which may limit a comprehensive understanding of patient behavior. Second, regional differences in health insurance reimbursement rates may influence healthcare decisions, but this study did not account for specific regional policy variations due to data limitations. Future research could incorporate regional health insurance policies to provide a more detailed assessment of how reimbursement rates affect hospital choices. Finally, this study relies on self-reported data, which may be subject to recall bias. Additionally, individuals' subjective health perceptions may be influenced by cultural, cognitive, and expectation factors, potentially leading to biases in reporting healthcare behavior. Future studies could integrate more objective medical records to enhance the accuracy of research findings.

Conclusion

This study examines the impact of health insurance reimbursement rates on hospital choices among middle-aged and elderly individuals in China, providing new empirical evidence. The findings indicate that higher reimbursement rates significantly reduce the likelihood of patients choosing primary and secondary hospitals while increasing their preference for tertiary hospitals. Specifically, a 1% increase in the reimbursement rate decreases the probability of choosing a primary hospital by 5.75% and a secondary hospital by 1.47%, while increasing the likelihood of selecting a tertiary hospital by 7.22%. These results highlight the crucial role of health insurance policies in guiding patients' healthcare choices. Policymakers can leverage reimbursement rate adjustments to optimize the distribution of patients across different hospital tiers, thereby enhancing the efficiency of healthcare resource allocation.

Additionally, the study finds that health check-ups play an important role in the relationship between reimbursement rates and hospital choices. Higher reimbursement rates encourage individuals to undergo health check-ups, which in turn influence their hospital selection, making them more likely to seek care at higher-tier hospitals. Health check-ups serve as an essential preventive measure, enabling early detection of potential health risks and increasing individuals' awareness of healthcare needs. This insight provides a valuable reference for designing more refined health insurance policies.

Our findings highlight the critical role of health insurance policies in shaping healthcare resource allocation, particularly in guiding patients' medical choices and promoting the development of a tiered healthcare

[10] Data from General Office of the State Council of the People's Republic of China. See.
http://www.gov.cn/xinwen/2016-10/25/content_5124174.htm

system. The results provide empirical support for policymakers to optimize reimbursement structures, serving as a valuable reference for future healthcare reforms. Moreover, the observed disparities in hospital choices among different socioeconomic groups underscore the need for more targeted policies that address the unique healthcare needs of vulnerable populations. Policymakers should consider strategies to enhance healthcare accessibility for rural residents, elderly individuals, and patients with chronic conditions, ensuring that increased reimbursement rates do not exacerbate healthcare inequalities. Additionally, efforts to improve the efficiency of healthcare services at lower-tier hospitals could encourage more balanced healthcare utilization, ultimately strengthening the effectiveness of the tiered healthcare system.

Abbreviations

CHARLS	China Health and Retirement Longitudinal Study
PSM	Propensity score matching
NRCMS	New Rural Cooperative Medical System
OLS	Ordinary least squares
GPSM	Generalized propensity score matching
HRS	Health risk subjective
QWB	Quality of Well-being Scale
MOB	Mobility
PAC	Physical activity
SAC	Social activity
CPX	Complexes
IV	Instrumental variable
ATT	Average Treatment Effect on the Treated group

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Authors' contributions
All authors contributed to the analysis and drafted the manuscript. The authors read and approved the final manuscript.

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Data availability
The primary data used in this study are from the publicly available database, China Health and Retirement Longitudinal Study (CHARLS) (http://charls.pku.edu.cn/). The project is directed by the National School of Development at Peking University, which has completed four rounds of national baseline surveys in 2011, 2013, 2015, and 2018. The datasets used during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

Author details
[1]School of Business, Zhengzhou University, Zhengzhou, China. [2]School of Economics, Xiamen University, Xiamen, China. [3]College of Economics and Management, Northeast Forestry University, No. 26 Hexing Road, Wenzheng Street, Xiangfang District, Harbin City, Heilongjiang Province, China.

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