International Journal for Equity in Health

RESEARCH

Open Access

Impact of a new case-based payment scheme on volume distribution across public hospitals in Zhejiang, China: does 'Same disease, same price' matter

Meiteng Yu[1], Jing Liu[2*] and Tao Zhang[1*]

Abstract

Background With the implementation of the hierarchical medical system (HMS) in China, Zhejiang Province introduced an innovative payment scheme called "payment method by disease types with point counting". This scheme was initially adopted in Jinhua in July 2017, and was later integrated with the "same disease, same price" policy in Hangzhou in January 2020. This study aimed to investigate the impact of these reforms on the distribution of health service volume.

Methods Data were obtained from 104 hospitals, including 12 tertiary and 14 secondary hospitals from each of four regions: Jinhua (intervention) vs. Taizhou (control), and Hangzhou (intervention) vs. Ningbo (control). A total of 3848 observation points were examined using two sets of controlled interrupted time series analyses to assess the effects of this new case-based payment, without and with "same disease, same price", on the proportion of discharges, total medical revenue and hospitalization revenue. The Herfindahl–Hirschman Index (HHI) were analyzed to evaluate changes in market competition.

Results Following the introduction of the new case-based payment without "same disease, same price", secondary hospitals in Jinhua experienced a significant decline in the proportion of discharges (β_6 = -0.1074, p = 0.047), total medical revenue (β_6 = -0.0729, p = 0.026), and hospitalization revenue (β_6 = -0.1062, p = 0.037) compared to those in Taizhou, while tertiary hospitals showed a non-significant increase. After incorporating "same disease, same price", the proportion of discharges (β_6 = 0.2015, p = 0.031), total medical revenue (β_6 = 0.1101, p = 0.041) and hospitalization revenue (β_6 = 0.1248, p = 0.032) in Hangzhou's secondary hospitals increased compared with Ningbo's, yet the differences in both the level and trend changes between tertiary hospitals in the two cities were not statistically significant. The HHI in Jinhua (β_7 = 0.0011, p = 0.043) presented an upward trend during the pilot period of the case-based payment, while the HHI in Hangzhou (β_6 = -0.0234, p = 0.021) decreased immediately after the introduction of "same disease, same price".

Conclusion This new case-based payment scheme may worsen the disproportionate distribution of service volume across hospitals of different levels. While "same disease, same price" shows potential benefits, further evidence

*Correspondence:
Jing Liu
jliu19871st@163.com
Tao Zhang
lucky1230405@163.com
Full list of author information is available at the end of the article

is needed to assess its effectiveness in promoting HMS. Policymakers should consider hospital interests in payment design and address unintended strategic behaviors.

Keywords Case-based payment, Public hospitals, Volume distribution, "Same disease, same price", China

Introduction

Since the initiation of hospital accreditation efforts in 1989, Chinese hospitals have been divided into three levels: tertiary, secondary, and primary hospitals [1]. Unfortunately, the concentration of well-trained medical personnel and advanced equipment in tertiary hospitals has exacerbated the disparities in the distribution of health service volume. Secondary and primary hospitals experience relatively low service volume, while tertiary hospitals often face overcrowding [2]. This imbalance results in the inefficient use of medical resources and impedes access to high-quality care for patients with severe conditions, thereby contributing to and aggravating health inequities [3]. In response, China implemented the hierarchical medical system (HMS) in September 2015 as a strategy to address inefficiencies in health services and promote a more equitable allocation of medical resources [4]. Nevertheless, by 2017, the total number of hospitalizations in China had reached 189.15 million, with tertiary, secondary, and primary hospitals accounting for 44.39%, 42.32% and 6.18%, respectively. This widening disparity highlights the ongoing challenge in establishing a rational and well-ordered healthcare delivery system [5, 6]. Several studies have identified the dominant fee-for-service (FFS) payment model as a significant factor contributing to this disparity, since it has historically incentivized tertiary hospitals to over-admit patients in pursuit of increased revenue [7, 8].

To manage the medical insurance budget and regulate health service delivery, the Chinese government has proposed transitioning from FFS to prospective payment systems, with a particular focus on diagnosis-related group (DRG)-based payment systems [9]. DRG-based payment systems have proven effective in reducing the out-of-pocket (OOP) costs and length of stay (LOS) for patients with targeted diseases, though they may not necessarily improve the quality of medical care [10–12]. In recent years, growing concern regarding the relationship between emerging DRG-based payment programs and the implementation of HMS [13–15]. As an economically developed province in China, Zhejiang redesigned an innovative case-based payment method, named "payment method by disease types with point counting", which was first piloted in Jinhua and has been progressively adopted in inpatient services at secondary and tertiary hospitals across the province since January 2020 [16]. Further details were provided in Sect. "Institutional Background".

Medical insurance payment methods have long been regarded as leverage to guide healthcare providers, and DRG-based payment is no exception. Theoretically, the payment standard for each DRG serves as the basis for prepaying hospitals, enabling them to estimate the maximum resource consumption threshold before patient admission [17]. To enhance their case mix index (CMI), which reflects treatment capabilities, tertiary hospitals are incentivized to proactively manage complex cases and transfer milder ones to lower-level facilities. Secondary hospitals, in turn, can admit more patients with common diseases and transfer cases that exceed their capacity to higher-level hospitals [18]. Under the DRG mechanism, the functional roles of hospitals at different levels are clarified, thereby promoting a more rational distribution of service volume. However, with the continuous exploration of DRG-based payment mechanism, researchers have found that under the current economic incentives, the design of this payment system fails to curb the expansion of certain more lucrative services and cannot achieve the desired effect [13, 19]. Furthermore, potential behaviors (e.g., patient selection, cost-shifting, readmissions) may adversely affect competition among hospitals [20, 21] (Fig. 1).

Prior studies have primarily focused on the impact of DRG-based payment systems on medical costs, efficiency and quality [10, 11, 22]. While some findings provide insights into how DRG-based payment affects the implementation of HMS, most research is limited to specific hospital levels or focuses solely on the individual behavior of healthcare providers, thus empirical evidence on public hospitals at different levels remains scarce [23–26]. Additionally, most existing studies examine the average effects of DRG-based payment at specific time points following implementation, with limited consideration of the evolving trends over time.

Based on hospital-level data in Zhejiang province, China, this study was intended to investigate the impact of the new case-based payment reforms on the distribution of service volume between secondary and tertiary hospitals through interrupted time series analysis (ITSA). Moreover, this article further identified potential defects of existing DRG-based payments, with the aim of providing valuable insights for regions facing similar challenges in optimizing the distribution of health services.

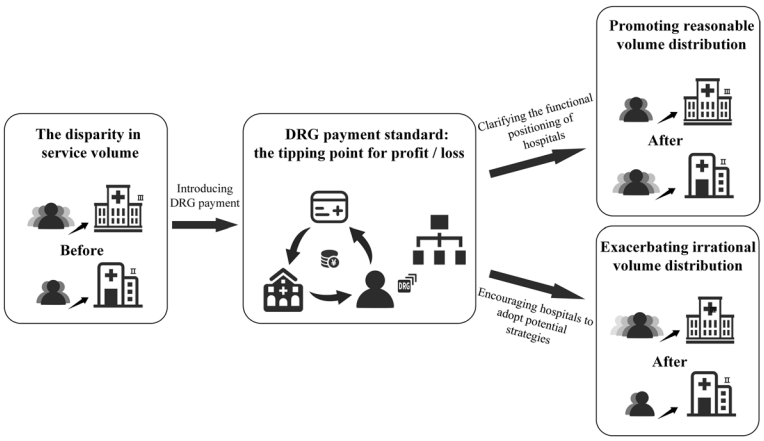

Fig. 1 The potential mechanism for the effects of DRG-based payment method on service volume distribution

Institutional background

In June 2017, the General Office of the State Council of China issued guidelines on further deepening the reform of basic medical insurance payment methods, encouraging qualified regions to actively explore the integration of point-based methods with case-based payment [27]. This is exactly the highlight of Zhejiang's payment reform. In July 2017, following a year of pilot testing, Jinhua comprehensively implemented the "payment method by disease types with point counting" across 49 urban hospitals. To be specific, after determining the regional global budget and DRG classification, the actual reimbursement for each hospital is obtained by the following two steps [16, 28] (Fig. 2).

The first step involves calculating the points for each DRG in a specific hospital. The point volume for a specific

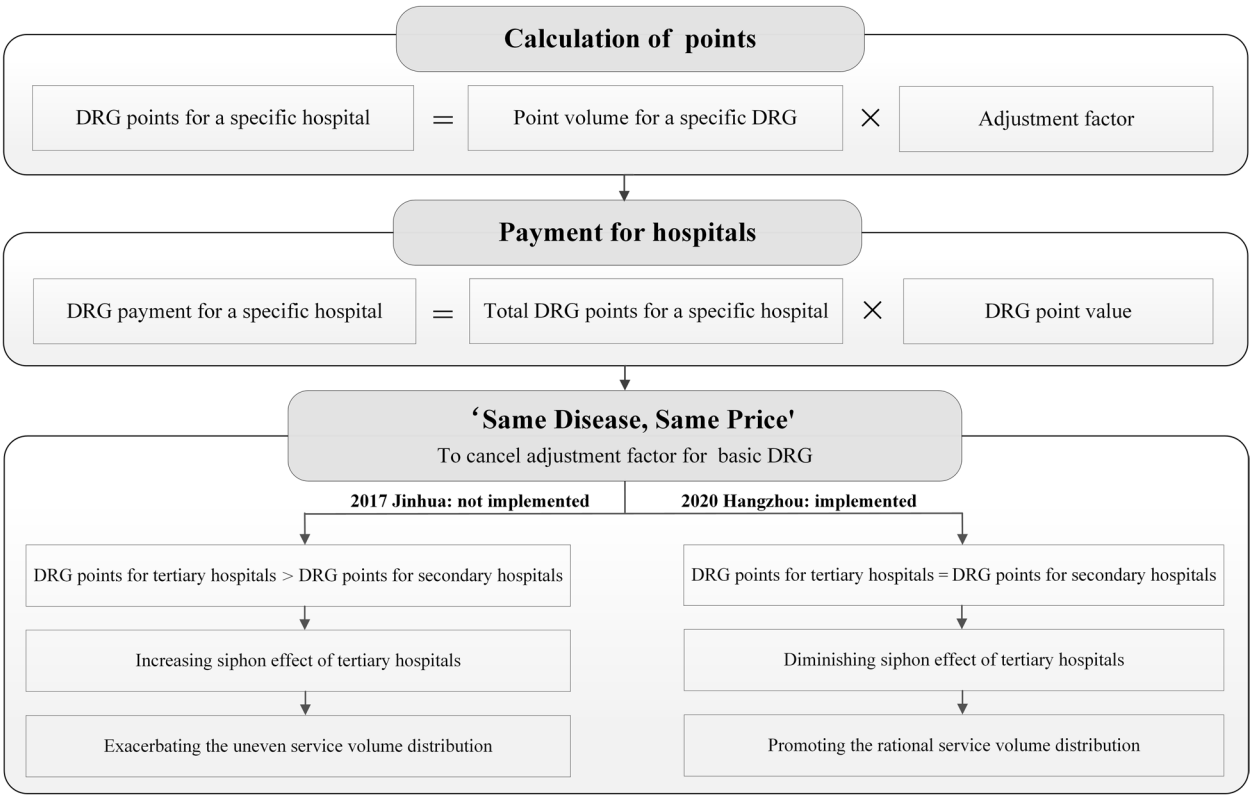

Fig. 2 Core components of "same disease, same price" under the new case-based payment

group is determined by the average expenditure per case in this DRG relative to the average expenditure for all cases. The adjustment factor reflects the proportional relationship between the average expenditure of each DRG in a specific hospital and the average expenditure of this DRG across the region. Then, the points for a specific DRG in this hospital are equal to the point volume for a specific group multiplied by the adjustment factor. Finally, the total points for this hospital are calculated by adding or subtracting the assessment points (rewards or penalties) from the total points of all hospitalized cases.

The second step is the payment settlement for each hospital. The monetary value for one point is determined by the total DRG expenditure relative to the total number of points in the whole region. As a result, the actual reimbursement for a specific hospital are equal to the sum of the monetary value of the total points.

Due to the relatively higher medical costs, it is generally observed that the adjustment factor for tertiary hospitals tends to be higher than that for secondary hospitals when treating the same disease. Previous research has proposed that this payment mechanism may induce tertiary hospitals to siphon more patients from secondary hospitals in order to earn more points [29]. To address this issue and achieve the goal of HMS, Hangzhou, the capital city of Zhejiang, integrated the "same disease, same price" policy into the case-based payment in January 2020, namely, to cancel the adjustment factor for specific basic DRGs and adopt a unified payment standard based on the average expenditure for the same disease across hospitals at different levels [30]. Up to September 2021, Hangzhou has implemented "same disease, same price" for a total of 50 DRGs [31]. Currently, "same disease, same price" has been considered as a critical strategy to reduce disparities in service volume across hospitals and to accelerate the development of HMS. Figure 2 summarizes the calculation rules of this new case-based payment and outlines the possible consequences of implementing or not implementing the "same disease, same price" policy.

Methods

Study designing and setting

Our study employed an ecologically controlled ITSA design, incorporating pre-intervention and post-intervention periods. To minimize time-varying confounding, Jinhua and Hangzhou were respectively set as intervention groups and compared with a control group not exposed to the intervention. Considering comparability with Jinhua and Hangzhou, we selected neighboring Taizhou and Ningbo as control groups respectively, both of which are located on the eastern coast of Zhejiang Province, as shown in Fig. 3. Table 1 shows that the two sets of intervention and control groups have similar characteristics in terms of economic development and health resource allocation [32]. In addition, Hangzhou launched the payment reform in January 2020, while Ningbo did not start officially until December 2020. Accordingly, the temporal gap between the intervention and control groups in terms of implementation time points enhances the accuracy and credibility of the policy effect assessment.

Data source and sampling

We employed a code random sampling strategy to select public hospitals from both the intervention and control cities. In total, we extracted discharge and revenue data from 104 local hospitals, including 12 tertiary hospitals and 14 secondary hospitals in each sample city. To avoid potential confounding due to significant differences in technical capabilities, top-level provincial hospitals were excluded from the analysis.

For each hospital, we collected monthly data points over a span of 37 consecutive months: from January 2016 to January 2019 for Jinhua (intervention group) and Taizhou (control group), and from July 2018 to July 2021 for Hangzhou (intervention group) and Ningbo (control group). After verifying the accuracy and completeness of the data, we analyzed a total of 3,848 observation points.

Outcome variables

Considering the main purpose of the study and the availability of data, we selected three proportion indicators to measure the distribution of health service volume: 1) proportion of discharges (%); 2) proportion of total medical revenue (%); 3) proportion of hospitalization revenue (%).

Herfindahl–Hirschman Index (HHI) is commonly used to assess market concentration and potential monopolistic behavior within an industry. By summing the squares of the discharge shares from secondary and tertiary hospitals within the entire inpatient services market, we can determine the degree of competition. A higher HHI value indicates a greater degree of monopoly in the inpatient services market, which also indirectly reflects the uneven distribution of inpatient service between secondary and tertiary hospitals [2, 33–35].

All outcome variables were calculated based on raw data extracted from the hospital management system. Table 2 provides detailed measurement methods and descriptive interpretations for each outcome variable.

Statistical analysis

For the outcome variables, we computed and compared means and standard deviations (SDs) before and after the intervention using Student's t-tests. Using multigroup ITSA, we evaluated both the instantaneous and

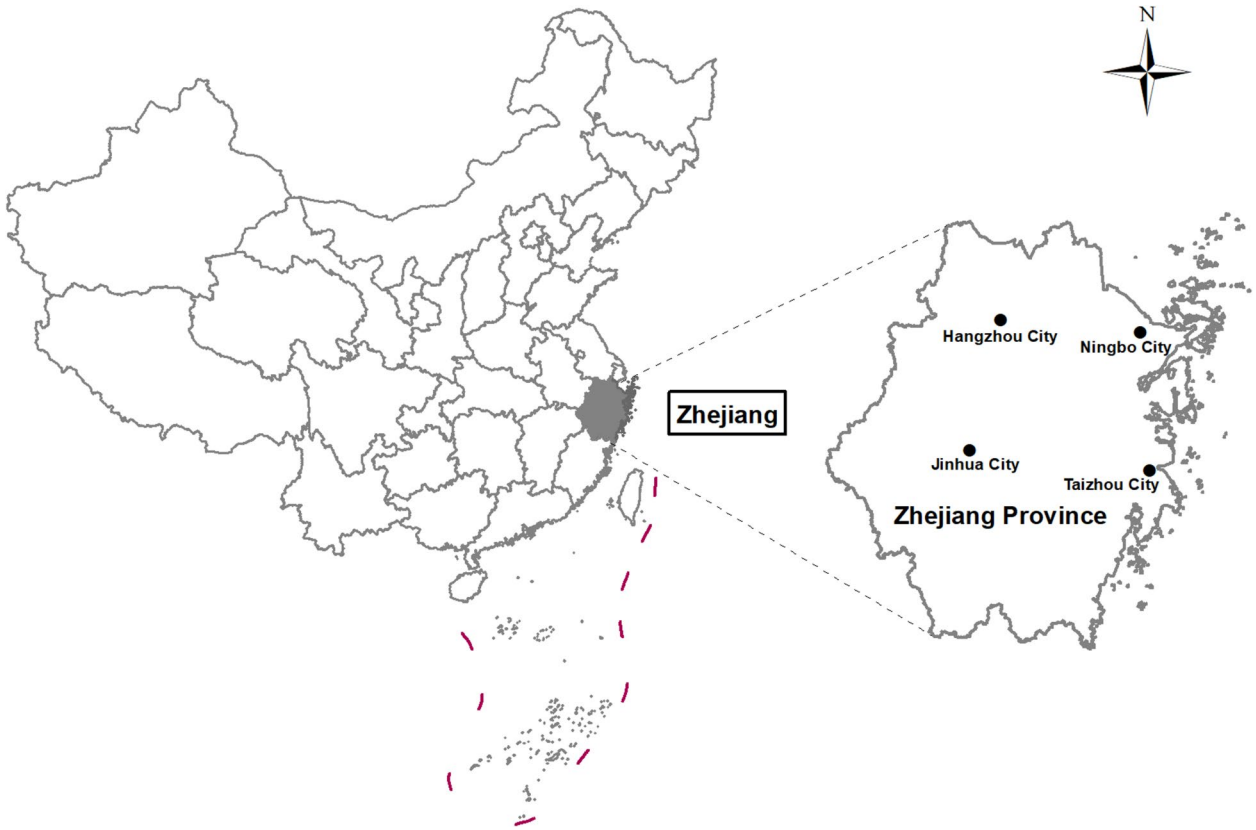

Fig. 3 Geolocation of sample cities in Zhejiang Province, China

Table 1 Socioeconomic status and health resources of sample cities in 2022

	Intervention one: case-based payment without "same disease, same price" policy		Intervention two: case-based payment with "same disease, same price" policy	
	Intervention group: Jinhua	Control group: Taizhou	Intervention group: Hangzhou	Control group: Ningbo
Resident population (10,000)	712.7	667.8	1237.6	961.8
GDP (billion RMB)	556.2	604.1	1,875.3	1,570.4
GDP per capita (RMB)	78,086	90,688	152,588	163,911
Number of healthcare institutions per 10,000	6.53	5.83	4.71	5.11
Number of beds per 1,000	5.23	5.04	7.51	4.87
Number of health personnel per 1,000	8.07	7.85	12.00	9.10
Number of practicing physicians per 1,000	3.19	3.22	4.64	3.74
Number of registered nurses per 1,000	3.49	3.39	5.32	3.92

GDP Gross Domestic Product, *RMB* Ren Min Bi

trend changes of outcome variables before and after the payment reforms [36]. The model adopts the following equation:

$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 X_t + \beta_3 X_t T_t + \beta_4 Z + \beta_5 Z T_t + \beta_6 Z X_t + \beta_7 Z X_t T_t + \varepsilon_t$$

where Y_t represents the outcome variable measured at each monthly time point t; T_t is a continuous variable representing the months since the start of observation

Table 2 Measurements and interpretations of outcome variables

Outcome variable	Measurement	Interpretation
Proportion of discharges	$\frac{\sum \text{The number of discharges from sample secondary or tertiary hospital}}{\sum \text{The number of discharges from each hospital}}$	It reflects the distribution of inpatient services. The wider the disparity in the proportion of secondary and tertiary hospitals, the poorer the implementation effectiveness of HMS is
Proportion of total medical revenue	$\frac{\sum \text{The total medical revenue of sample secondary or tertiary hospital}}{\sum \text{The total medical revenue of each hospital}}$	It reflects the distribution of service revenue. The larger the gap between the proportion of secondary and tertiary hospitals, the more uneven the revenue distribution is
Proportion of hospitalization revenue	$\frac{\sum \text{The hospitalization revenue of secondary or tertiary hospital}}{\sum \text{The hospitalization revenue of each hospital}}$	It reflects the distribution of inpatient service revenue. The larger the gap between the proportion of secondary and tertiary hospitals, the more uneven the hospitalization revenue distribution is
HHI	$\sum_{i=2}^{2}\left(\frac{X_i}{X}\right)^2 = \sum_{i=2}^{2} S_i^2$ (Where X_i represents the number of discharges from secondary or tertiary hospitals; X denotes the total number of discharges in the entire inpatient services market; S_i indicates the share of discharges from secondary or tertiary hospitals within the overall inpatient services market.)	It reflects the degree of competition in the inpatient services market. A higher HHI indicates a greater degree of market concentration and monopoly, and indirectly reflects the uneven distribution of inpatient service between secondary and tertiary hospitals

period. X_t is a dummy variable with a value of either 0 or 1, representing the period before or after the intervention, respectively. Z is also a dummy variable with a value of either 0 or 1, indicating whether a hospital was in the intervention or control group. X_tT_t, ZT_t, and ZX_tT_t represent all interaction terms among the variables described above. β_1 and β_3 represent the slope of the control group in pre- and post-intervention periods, respectively. β_2 is the change in the trend of the control group after the intervention. β_4 and β_5 represent the differences in intercepts and slopes between the intervention and control groups prior to the intervention, while β_6 and β_7 indicate the differences in levels and slopes changes after the intervention between the two groups. Ultimately, the effects of the two different stages of the new case-based payment reforms (without or with "same disease, same price") were estimated by observing whether the intervention groups deviated from baseline levels (β_6) and trends (β_7) to a greater extent than the control groups.

ITSA was conducted separately for the tertiary hospitals and secondary hospitals to assess the effects on hospitals at different levels. July 2017 was set as the intervention point for the new case-based payment without "same disease, same price" (Jinhua vs. Taizhou), while January 2020 for the payment with "same disease, same price" (Hangzhou vs. Ningbo). To address autocorrelation and potential heteroskedasticity, we employed ordinary least squares regression with Newey-West standard errors [36]. All statistical analyses were performed using Stata 14.0.

Results

Characteristics of outcome variables

Before the introduction of the new case-based payment scheme, the four outcome variables were similar between the intervention and control groups. Overall, notable changes were observed after the payment reforms (Tables 3 and 4). Figure S1 in the Additional file 1 displays the time series graphs for outcome variables in the intervention and control groups.

Table 3 reports the monthly mean (SD) values for the proportion indicators of tertiary and secondary hospitals in the intervention and control groups. After the reform of the new payment without "same disease, same price", the proportion of discharges (t = -5.2920, $p < 0.001$), total medical revenue (t = -4.4960, $p < 0.001$) and hospitalization revenue (t = -3.5437, $p = 0.003$) in secondary hospitals in Jinhua significantly decreased, in contrast to the control group (Taizhou). Meanwhile, the three indicators for tertiary hospitals increased throughout the study period. Following the payment reform combined with the "same disease, same price" policy, the proportion of total medical revenue (t = 2.2641, $p = 0.037$) and hospitalization revenue (t = 1.6400, $p = 0.119$) in secondary hospitals in Hangzhou increased to some extent, whereas the corresponding indicators for tertiary hospitals exhibited a downward trend.

Table 4 presents the monthly mean (SD) values of the HHI for the intervention and control groups. After the reform without the "same disease, same price" policy, the HHI in Jinhua (t = 4.1014, $p = 0.001$) increased

Table 3 Monthly mean (SD) values of proportion indicators in intervention and control groups

Indicator	Region	Secondary hospitals			Tertiary hospitals		
		Pre-intervention	Post-intervention	p	Pre-intervention	Post-intervention	p
Proportion of discharges	Jinhua	1.5936 (0.0466)	1.4762 (0.0631)	< 0.001	6.2130 (0.0579)	6.3368 (0.0819)	< 0.001
	Taizhou	1.7454 (0.0333)	1.7793 (0.0361)	0.006	6.2119 (0.0379)	6.1694 (0.0467)	0.015
	Hangzhou	1.6839 (0.0385)	1.7061 (0.0998)	0.431	5.4363 (0.0523)	5.3619 (0.1203)	0.057
	Ningbo	1.4023 (0.0322)	1.2928 (0.0482)	< 0.001	5.5661 (0.0450)	5.7325 (0.0991)	< 0.001
Proportion of total medical revenue	Jinhua	1.3352 (0.0224)	1.2922 (0.0305)	< 0.001	6.4527 (0.0286)	6.5061 (0.0441)	0.001
	Taizhou	1.5724 (0.0230)	1.6341 (0.0302)	< 0.001	6.4108 (0.0288)	6.3236 (0.0519)	< 0.001
	Hangzhou	1.3102 (0.0428)	1.3537 (0.0622)	0.037	6.0390 (0.0506)	5.9613 (0.0653)	0.002
	Ningbo	1.3585 (0.0298)	1.3073 (0.0639)	0.007	5.6366 (0.0356)	5.6959 (0.0729)	0.016
Proportion of hospitalization revenue	Jinhua	1.2538 (0.0704)	1.1822 (0.0442)	0.003	6.5983 (0.0842)	6.6672 (0.0822)	0.028
	Taizhou	1.3999 (0.0309)	1.4759 (0.0559)	< 0.001	6.6303 (0.0389)	6.4966 (0.1172)	< 0.001
	Hangzhou	1.2213 (0.0435)	1.2478 (0.0502)	0.119	6.2740 (0.0575)	6.1993 (0.0556)	0.005
	Ningbo	0.9937 (0.0283)	0.9445 (0.0347)	0.001	5.8652 (0.0503)	5.9286 (0.0778)	0.025

Table 4 Monthly mean (SD) values of the HHI in intervention and control groups

Region	Pre-intervention	Post-intervention	p
Jinhua	0.6057 (0.0074)	0.6211 (0.0115)	0.001
Taizhou	0.6154 (0.0047)	0.6100 (0.0070)	0.024
Hangzhou	0.4812 (0.0069)	0.4714 (0.0111)	0.015
Ningbo	0.4847 (0.0057)	0.5060 (0.0147)	< 0.001

significantly compared to the control group (Taizhou). However, following the implementation of the payment reform with the "same disease, same price" policy, the HHI in Hangzhou (t = -2.6955, $p = 0.015$) decreased significantly compared to the control group (Ningbo).

Effects of the new case-based payment without "same disease, same price" on volume distribution

Table 5 and Fig. 4 show the controlled ITSA results for the proportion indicators of secondary and tertiary hospitals in Jinhua and Taizhou. Prior to the payment reform, the intervention and control group exhibited similar and nearly parallel proportion of discharges, total medical revenue and hospitalization revenue, indicating that the two groups of regions are highly comparable. After the reform of the new case-based payment without the "same disease, same price" policy, unlike control group (Taizhou), secondary hospitals in Jinhua experienced a significant immediate decrease in the average proportion of discharges ($\beta_6 = -0.1074$, $p = 0.047$), total medical revenue ($\beta_6 = -0.0729$, $p = 0.026$), and hospitalization revenue ($\beta_6 = -0.1062$, $p = 0.037$). Despite the increase in proportion indicators for Jinhua's tertiary hospitals, the overall differences in both level and trend changes between two groups were not statistically significant.

Effects of the new case-based payment with "same disease, same price" on volume distribution

Table 6 and Fig. 5 present the controlled ITSA results for the proportion indicators of secondary and tertiary hospitals in Hangzhou and Ningbo. Before the policy intervention, the differences in both the levels and trends between the intervention and control group were not statistically significant. Following the implementation of the new payment combined with "same disease, same price", compared to the control group (Ningbo), the overall changes in tertiary hospitals were not remarkable, whereas the average proportion of discharges ($\beta_6 = 0.2015$, $p = 0.031$), total medical revenue ($\beta_6 = 0.1101$, $p = 0.041$) and hospitalization revenue ($\beta_6 = 0.1248$, $p = 0.032$) for secondary hospitals in Hangzhou displayed a large increase within a short period. Nevertheless, the differences in trend changes of these three indicators between the intervention and control group were not significant.

Effects of the new case-based payment on inpatient services market competition

Table 7 and Fig. 6 present the results of controlled ITSA regarding the degree of competition in the inpatient services market across the two sets of regions. Prior to the policy intervention, although there were substantial differences between the initial intercepts in Jinhua and Taizhou, as well as the trends observed in Hangzhou and Ningbo, the payment reform notably affected the HHI. After the reform, the HHI in Jinhua ($\beta_7 = 0.0011$, $p = 0.030$) showed an upward trend, in contrast to Taizhou. In comparison to Ningbo, the HHI in Hangzhou

Table 5 Coefficients (standard errors) for effects of the new case-based payment without "same disease, same price"

	Secondary hospitals			Tertiary hospitals		
	Proportion of discharges	**Proportion of total medical revenue**	**Proportion of hospitalization revenue**	**Proportion of discharges**	**Proportion of total medical revenue**	**Proportion of hospitalization revenue**
Before intervention						
Level (control group, β_0)	1.7503*** (0.2530)	1.5556*** (0.2006)	1.3851*** (0.2439)	6.2201*** (1.2338)	6.4378*** (1.3714)	6.6577*** (1.6154)
Trend (control group, β_1)	-0.0006 (0.0047)	0.0020 (0.0032)	0.0017 (0.0038)	-0.0010 (0.0112)	-0.0032 (0.0141)	-0.0032 (0.0151)
Difference in level (β_4)	-0.1502 (0.4421)	-0.2260 (0.3425)	-0.1461 (0.3975)	-0.0201 (1.7699)	0.0128 (1.9463)	-0.0498 (2.3192)
Difference in trend (β_5)	-0.0002 (0.0056)	-0.0013 (0.0036)	-0.0001 (0.0042)	0.0025 (0.0132)	0.0034 (0.0159)	0.0021 (0.0167)
After intervention						
Level change (control group, β_2)	0.0554 (0.0324)	0.0480 (0.0256)	0.0752 (0.0404)	-0.0206 (0.0757)	-0.0360 (0.0810)	-0.0467 (0.1105)
Change in trend (control group, β_3)	-0.0012 (0.0060)	-0.0026 (0.0035)	-0.0035 (0.0052)	-0.0005 (0.0163)	0.0008 (0.0133)	-0.0031 (0.0198)
Difference in level change (β_6)	-0.1074* (0.0540)	-0.0729* (0.0327)	-0.1062* (0.0508)	0.0454 (0.1016)	0.0542 (0.1252)	0.0400 (0.1626)
Difference in change in trend (β_7)	-0.0045 (0.0084)	-0.0008 (0.0048)	-0.0046 (0.0083)	0.0083 (0.0222)	0.0025 (0.0187)	0.0138 (0.0311)

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

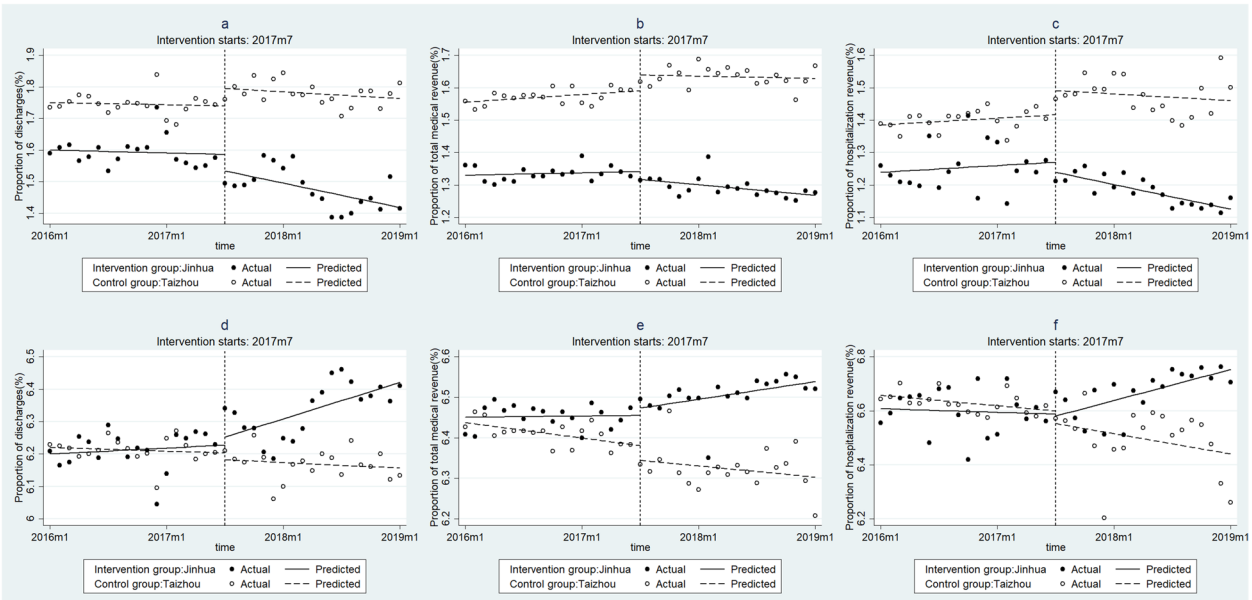

Fig. 4 Interrupted time series graphs for the proportion of discharges, total medical revenue and hospitalization revenue in Jinhua and Taizhou. **a**, **b**, **c** are proportion indicators of secondary hospitals; **d**, **e**, **f** are proportion indicators of tertiary hospitals

Table 6 Coefficients (standard errors) for effects of the new case-based payment with "same disease, same price"

	Secondary hospitals			Tertiary hospitals		
	Proportion of discharges	**Proportion of total medical revenue**	**Proportion of hospitalization revenue**	**Proportion of discharges**	**Proportion of total medical revenue**	**Proportion of hospitalization revenue**
Before intervention						
Level (control group, β_0)	1.3766*** (0.2214)	1.3548*** (0.1979)	0.9673*** (0.2123)	5.6051*** (0.8386)	5.6316*** (0.8719)	5.8879*** (1.1502)
Trend (control group, β_1)	0.0030 (0.0033)	0.0004 (0.0020)	0.0031 (0.0032)	-0.0046 (0.0155)	0.0006 (0.0056)	-0.0027 (0.0112)
Difference in level (β_4)	0.3226 (0.2970)	-0.0527 (0.2645)	0.2676 (0.2637)	-0.1490 (1.0129)	0.4183 (1.1520)	0.3923 (1.4343)
Difference in trend (β_5)	-0.0048 (0.0042)	0.0005 (0.0033)	-0.0047 (0.0041)	0.0023 (0.0173)	-0.0019 (0.0083)	0.0019 (0.0133)
After intervention						
Level change (control group, β_2)	-0.0933 (0.0655)	-0.0146 (0.0312)	-0.0474 (0.0326)	0.0990 (0.0913)	-0.0126 (0.0749)	0.0436 (0.0717)
Change in trend (control group, β_3)	-0.0080 (0.0044)	-0.0053 (0.0032)	-0.0066 (0.0058)	0.0169 (0.0294)	0.0068 (0.0203)	0.0077 (0.0302)
Difference in level change (β_6)	0.2015* (0.0932)	0.1101* (0.0539)	0.1248* (0.0584)	-0.2320 (0.1731)	-0.1003 (0.1835)	-0.1259 (0.2123)
Difference in change in trend (β_7)	0.0022 (0.0081)	-0.0028 (0.0061)	0.0042 (0.0081)	-0.0056 (0.0366)	-0.0003 (0.0246)	-0.0053 (0.0357)

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

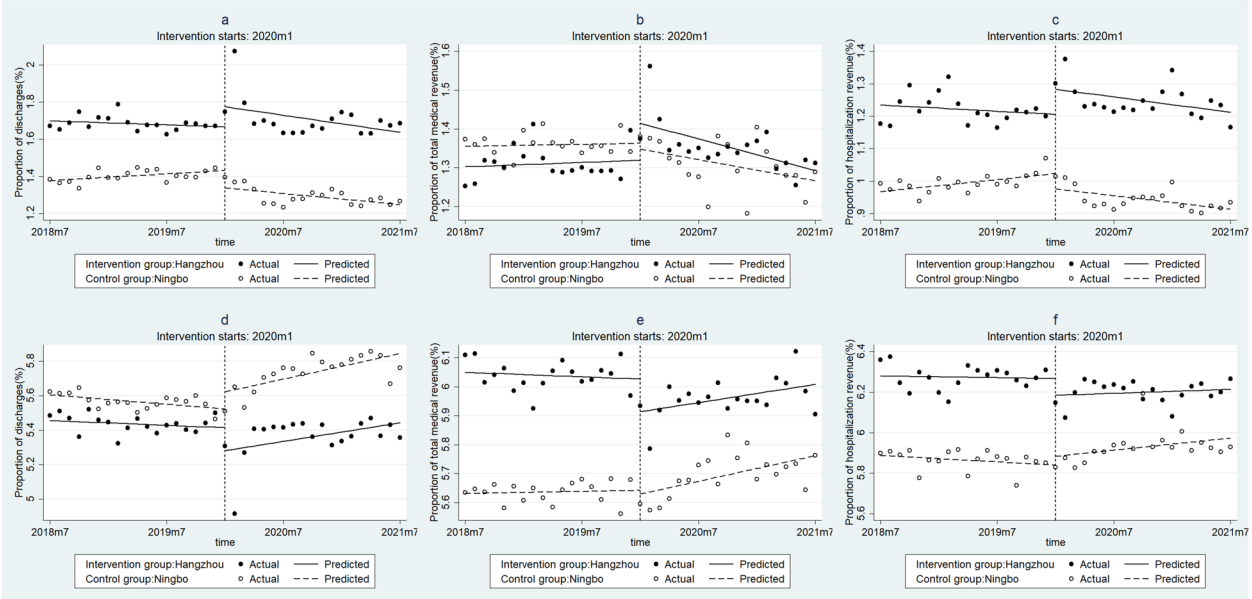

Fig. 5 Interrupted time series graphs for the proportion of discharges, total medical revenue and hospitalization revenue in Hangzhou and Ningbo. **a**, **b**, **c** are proportion indicators of secondary hospitals; **d**, **e**, **f** are proportion indicators of tertiary hospitals

(β_6 = -0.0234, p = 0.021) significantly decreased in the short term following the implementation of the case-based payment combined with the "same disease, same price" policy.

Discussion

This study employed a quasi-experimental design to evaluate the impact of the new case-based payment on service volume distribution across public hospitals in

Table 7 Coefficients (standard errors) for effects of the new case-based payment on HHI

	Jinhua vs. Taizhou	Hangzhou vs. Ningbo
Before intervention		
Level (control group, β_0)	0.6172*** (0.0010)	0.4896*** (0.0020)
Trend (control group, β_1)	-0.0002 (0.0001)	-0.0006* (0.0003)
Difference in level (β_4)	-0.0134*** (0.0025)	-0.0042 (0.0036)
Difference in trend (β_5)	0.0004 (0.0003)	0.0001 (0.0004)
After intervention		
Level change (control group, β_2)	-0.0012 (0.0037)	0.0110 (0.0061)
Change in trend (control group, β_3)	-0.0001 (0.0003)	0.0023** (0.0006)
Difference in level change (β_6)	0.0024 (0.0066)	-0.0234* (0.0099)
Difference in change in trend (β_7)	0.0011* (0.0005)	-0.0010 (0.0009)

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

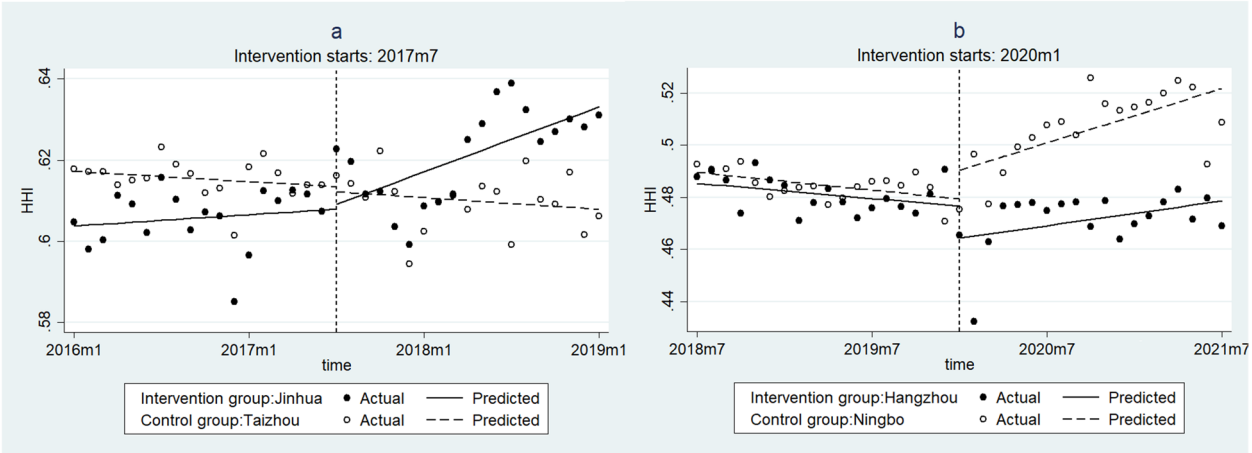

Fig. 6 Interrupted time series graphs for inpatient services market competition in intervention and control groups. **a** is the HHI in Jinhua and Taizhou; **b** is the HHI in Hangzhou and Ningbo

Zhejiang, China. Our findings suggest that the new case-based payment system may exacerbate the disparities in service volume between secondary and tertiary hospitals. While the "same disease, same price" policy has the potential to alleviate the over-concentration of patients in tertiary hospitals, its effectiveness in addressing the underlying imbalance in health service distribution remains uncertain.

Following the reform of the new case-based payment scheme without "same disease, same price", the proportion indicators for secondary hospitals decreased significantly, and the HHI showed a noticeable upward trend. According to previous studies, hospitals are strongly incentivized to increase service volume under DRG-based payment system due to the potential for enhanced profitability within DRGs [37, 38]. Similarly, under this new case-based payment scheme, we speculate that the differential compensation caused by the adjustment factor in the insurance reimbursement formula may encourage tertiary hospitals to leverage their competitive advantages to accumulate more points, thereby placing secondary hospitals at a significant competitive disadvantage in the inpatient services market [29]. As a result, this scheme appears to have further entrenched the concentration of inpatients in tertiary hospitals, which hinders the effective implementation of the HMS.

Encouragingly, we observed that after the introduction of "same disease, same price" in the new case-based payment system, the proportion indicators for secondary hospitals all increased, while the parameter β_6 for these indicators for tertiary hospitals became negative, leading to a significant drop in the HHI. This suggests that the service volume is more evenly distributed compared to the past, with less concentration in large tertiary hospitals. One possible explanation is that with the "same disease, same price" policy, tertiary hospitals are assigned the same number of points as secondary hospitals when treating patients from the same DRG [39, 40]. Due to

higher medical costs and reduced benefits, tertiary hospitals may consciously limit the intake of patients from these groups. Simultaneously, the more equitable insurance payment system also incentivizes secondary hospitals to improve operational efficiency and, to some extent, treat a greater number of patients with common diseases.

Notably, after the introduction of the "same disease, same price" policy, the reduction in the corresponding proportion indicators for tertiary hospitals was not as pronounced as expected, which means the increase in service volume at secondary hospitals may not be entirely attributable to patient referrals from tertiary hospitals. Previous studies have indicated that DRG-based payment can incentivize violations such as code creep (i.e., the substitution of less severe diagnoses with more severe ones) and unnecessary admissions [41–43]. Therefore, some tertiary hospitals may continue to treat common cases for profit, and the increased service volume in secondary hospitals might stem from their admission of patients who require only outpatient care. This finding highlights the need for policymakers to incorporate referral rates into the performance evaluation system for public hospitals and to closely monitor the accuracy of medical record documentation and coding.

Furthermore, compared to immediate changes, the long-term trends in outcomes resulting from the new case-based payment scheme with the "same disease, same price" policy seem insignificant. Firstly, the short-term effect may be due to the fact that the policy has just been implemented, and hospitals have yet to adopt strategic actions, thereby showing the expected effects. However, since DRG-based payment is still in its initial stage in China, and effective supervision is not in place, large tertiary hospitals may make strategic adjustments later, such as reducing LOS, decomposing hospitalizations, increasing readmissions or exploiting other inappropriate avenues to offset revenue losses [44–49]. Hence, it is imperative for policymakers to continuously regulate hospitals' emerging strategic behavior and evaluate the system barriers. Additionally, our study was conducted in relatively developed cities where high-quality healthcare resources are primarily concentrated in large tertiary hospitals. Patients in these cities generally have greater financial capacity, enabling them to afford the high hospitalization costs associated with these hospitals. As a result, the impact of the "same disease, same price" policy on their choice of inpatient care may be less significant [50–52].

Limitations

This study has several limitations. First, the interpretation of the results should be interpreted with caution, as we selected a developed province for our sample, meaning that the policy effects may not be generalizable to other regions. Second, we analyzed only 19 months of post-policy implementation data, limiting our ability to assess the longer-term effects of the payment reforms. Third, due to the unavailability of referral data, we could not determine whether the increase in service share at secondary hospitals under the "same disease, same price" policy was due to patient transfers from tertiary hospitals, despite observing non-significant parameters for tertiary hospitals. Finally, during the study period, the COVID-19 pandemic and related policy changes (e.g., encouraging residents to delay non-emergency medical visits and concentrating medical resources on severe cases) occurred. Although a quasi-experimental design was employed to control for these effects, intervention and control groups may have responded differently, potentially leading to the deviations in the estimated effects of the payment reforms [53–55].

Conclusion

The new case-based payment scheme may exacerbate the disparities in service volume distribution between secondary and tertiary hospitals. While the "same disease, same price" policy holds potential for increasing the service volume in secondary hospitals, the decline in tertiary hospitals remains minimal. Thus, further research using long-term observational data is essential to determine whether this policy can effectively address the imbalanced service distribution. Additionally, policymakers should consider a more equitable allocation of benefits across hospitals when designing payment schemes, and continuously monitor hospitals' strategic responses to payment reforms.

Abbreviations

HMS	Hierarchical Medical System
FFS	Fee for Service
DRG	Diagnosis Related Group
OOP	Out of Pocket
LOS	Length of Stay
CMI	Case Mix Index
ITSA	Interrupted Time Series Analysis
HHI	Herfindahl Hirschman Index
SDs	Standard Deviations

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12939-025-02375-9.

Additional file 1.

Acknowledgements

The authors would like to thank sample hospitals for their support in conducting this study.

Authors' contributions
T.Z. collected the data and conceived this study. M.Y. performed the statistical analysis and wrote the first draft. T.Z. and J.L. provided substantial review and editing for content. All authors have reviewed and agreed to the final version of the manuscript.

Funding
This study was supported by the National Natural Science Foundation of China (Grant No. 72304082, 72204153).

Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Ethical approval was received from the Ethics Committee of Hangzhou Normal University (2023–1042). The study was performed in accordance with the Declaration of Helsinki. Consent to participate was not required, as this study does not involve data related to any animal or human.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Author details
[1]Department of Health Policy and Management, School of Public Health, Hangzhou Normal University, Hangzhou, China. [2]Administrative Office, Shantou University School of Medicine Affiliated Yuebei People's Hospital, Shaoguan, China.

Received: 31 July 2024 Accepted: 1 January 2025
Published online: 14 January 2025

References

1. Lancet. A tiered health-care delivery system for China. Lancet. 2019;393(10177):1178.
2. Jiang Q, Pan J. The Evolving Hospital Market in China After the 2009 Healthcare Reform. Inquiry: A Journal of Medical Care Organization, Provision and Financing. 2020;57:46958020968783.
3. Liao R, Liu YQ, Peng SZ, Feng XL. Factors affecting health care users' first contact with primary health care facilities in north eastern China, 2008–2018. BMJ Glob Health. 2021;6(2):e003907.
4. Zhou ZL, Zhao YX, Shen C, Lai S, Nawaz R, Gao JM. Evaluating the effect of hierarchical medical system on health seeking behavior: A difference-in-differences analysis in China. Soc Sci Med. 2021;268: 113372.
5. National Bureau of Statistics of China. China Health Statistics Yearbook in 2022. https://www.stats.gov.cn/sj/ndsj/2022/indexeh.htm. Accessed 10 Feb 2024.
6. Yip W, Fu HQ, Chen AT, Zhai TM, Jian WY, Xu R, Pan J, Hu M, Zhou ZL, Chen QL, Mao WH, Sun Q, Chen W. 10 years of health-care reform in China: progress and gaps in Universal Health Coverage. Lancet. 2019;394(10204):1192–204.
7. Gosden T, Forland F, Kristiansen IS, Sutton M, Leese B, Giuffrida A, Sergison M, Pedersen L. Capitation, salary, fee-for-service and mixed systems of payment: effects on the behaviour of primary care physicians. The Cochrane Database of Systematic Reviews. 2000;2000(3):CD002215.
8. Jia LY, Meng QY, Scott A, Yuan BB, Zhang L. Payment methods for healthcare providers working in outpatient healthcare settings. The Cochrane Database of Systematic Reviews. 2021;1(1):CD011865.
9. Yu LH, Lang JJ. Diagnosis-related Groups (DRG) pricing and payment policy in China: where are we? Hepatobiliary Surg Nutr. 2020;9(6):771–3.
10. Jian WY, Lu M, Chan KY, Poon AN, Han W, Hu M, Yip W. Payment Reform Pilot In Beijing Hospitals Reduced Expenditures And Out-Of-Pocket Payments Per Admission. Health Aff. 2015;34(10):1745–52.
11. Zhang J. The impact of a diagnosis-related group-based prospective payment experiment: the experience of Shanghai. Appl Econ Lett. 2010;17(18):1797–803.
12. Jian WY, Lu M, Liu GF, Chan KY, Poon AN. Beijing's diagnosis-related group payment reform pilot: Impact on quality of acute myocardial infarction care. Soc Sci Med. 2019;243:112590.
13. Shi H, Cheng Z, Liu Z, Zhang Y, Zhang P. Does a new case-based payment system promote the construction of the ordered health delivery system? Evidence from a pilot city in China. Int J Equity Health. 2024;23(1):55.
14. He SC, Yang CH, Ying JC, Zhao DR, Jin XF, Zhou MH. Analysis on the Implementation Path of DRG-Based Hierarchical Medical System. Health Econ Res. 2020;37(04):30–2 (in Chinese).
15. Jia XQ, Wang H, Jiang XM, Zhao YW, Wang XS. Exploration and thinking on the path of hierarchical diagnosis and treatment of sinking disease groups in a city's Grade III hospital under the DRG payment reform of medical insurance. Chin Hosp. 2022;26(09):6–9 (in Chinese).
16. Jiang XZ. Exploration and practice of DRGs payment method in Jinhua. China Health Insur. 2019;6:42–5 (in Chinese).
17. Liu JH, Capurro D, Nguyen A, Verspoor K. Early prediction of diagnostic-related groups and estimation of hospital cost by processing clinical notes. NPJ Digit Med. 2021;4:103.
18. Zhu TT, Chen C, Zhang XX, Yang QR, Hu YP, Liu RY, Zhang XY, Dong Y. Differences in inpatient performance of public general hospitals following implementation of a points-counting payment based on diagnosis-related group: a robust multiple interrupted time series study in Wenzhou, China. BMJ Open. 2024;14(3):e073913.
19. Quentin W, Scheller-Kreinsen D, Blümel M, Geissler A, Busse R. Hospital Payment Based On Diagnosis-Related Groups Differs In Europe And Holds Lessons For The United States. Health Aff. 2013;32(4):713–23.
20. Widmer P, Zweifel P. Unintended Consequences of Hospital Payment: The Case of Swiss Diagnosis Related Groups. Hosp Pract Res. 2016;1(4):105–13.
21. Kim SJ, Park E-C, Kim SJ, Han K-T, Han E, Jang S-I, Kim TH. The effect of competition on the relationship between the introduction of the DRG system and quality of care in Korea. The Eur J Public Health. 2016;26(1):42–7.
22. Chen YJ, Zhang XY, Yan JQ, Xue T, Qian MC, Ying XH. Impact of Diagnosis-Related Groups on Inpatient Quality of Health Care: A Systematic Review and Meta-Analysis. Inquiry: A Journal of Medical Care Organization, Provision and Financing. 2023;60:469580231167011.
23. Cheng S-H, Chen C-C, Tsai S-L. The impacts of DRG-based payments on health care provider behaviors under a universal coverage system: a population-based study. Health Policy. 2012;107(2–3):202–8.
24. Fourie C, Biller-Andorno N, Wild V. Systematically evaluating the impact of diagnosis-related groups (DRGs) on health care delivery: a matrix of ethical implications. Health Policy. 2014;115(2–3):157–64.
25. Zou K, Li HY, Zhou D, Liao ZJ. The effects of diagnosis-related groups payment on hospital healthcare in China: a systematic review. BMC Health Serv Res. 2020;20(1):112.
26. Street A, O'Reilly J, Ward P, Mason A. DRG-based hospital payment and efficiency: theory, evidence, and challenges. Diagnosis-related groups in Europe: Moving towards transparency, efficiency and quality in hospitals. 2011:93–114.
27. General Office of the State Council of the People's Republic of China. Guiding Opinions on Further Deepening the Reform of Basic Medical Insurance Payment Methods. https://www.gov.cn/gongbao/content/2017/content_5210497.htm. Accessed 10 Feb 2024.
28. Shao NJ. Evaluation XY and Analysis on the DRGs payment reform in Jinhua. China Health Insur. 2018;4:41–3 (in Chinese).
29. Zhang T, Lu BY, Yan ZH, Huang XJ, Lu W. Impacts of a New Episode-Based Payment Scheme on Volume, Expenditures, and Efficiency in Public Hospitals: A Quasi-Experimental Interrupted Time-Series Study in Jinhua. China Risk Manag Healthc Policy. 2022;15:1659–69.
30. Zhejiang Provincial Medical Security Bureau. Notice on the issuance of the "Implementation Rules for DRGs point payment of hospitalization expenses for basic medical insurance in Zhejiang Province and Hangzhou City (Trial)". http://ybj.zj.gov.cn/art/2020/5/11/art_1604513_42901498.html. Accessed 11 Feb 2024.
31. Zhejiang Provincial Medical Security Bureau. Notice on Implementing "Same Disease, Same Price" for DRGs to Promote Hierarchical Diagnosis

and Treatment. http://ybj.zj.gov.cn/art/2021/9/10/art_1229225623_2354996.html. Accessed 15 Feb 2024.
32. Zhejiang Provincial Bureau of Statistics. Zhejiang Statistical Yearbook-2023. https://tjj.zj.gov.cn/art/2023/10/16/art_1525563_58960915.html. Accessed 12 Feb 2024.
33. Vasilache S, PREJMEREAN MC. Estimation of Romanian hospitals efficiency in relation to hospital market competition. Management. 2008;3(3):97–106.
34. Torun N, Celik Y, Younis MZ. Competition among Turkish hospitals and its effect on hospital efficiency and service quality. J Health Care Finance. 2013;40(2):42–58.
35. Strobel RJ, Likosky DS, Brescia AA, Kim KM, Wu X, Patel HJ, Deeb GM, Thompson MP. The Effect of Hospital Market Competition on the Adoption of Transcatheter Aortic Valve Replacement. Ann Thorac Surg. 2020;109(2):473–9.
36. Linden A. Conducting interrupted time-series analysis for single- and multiple-group comparisons. Stata J. 2015;15(2):480–500.
37. Geissler A, Quentin W, Scheller Kreinsen D, Busse R. Introduction to DRGs in Europe: Common objectives across different hospital systems. Diagnosis-related Groups in Europe: Moving Towards Transparency, Efficiency and Quality in Hospitals. 2011:9–21.
38. Feng LF, Tian Y, He M, Tang J, Peng Y, Dong CJ, Xu WZ, Wang T, He JJ. Impact of DRGs-based inpatient service management on the performance of regional inpatient services in Shanghai, China: an interrupted time series study, 2013–2019. BMC Health Serv Res. 2020;20(1):942.
39. Wei T, Feng W. Impact analysis of the payment reform of "same disease with the same price in the same level of hospital" diagnosis-related group based on L City, Guizhou Province: an empirical study. Lancet. 2019;394:S63.
40. Hamada H, Sekimoto M, Imanaka Y. Effects of the per diem prospective payment system with DRG-like grouping system (DPC/PDPS) on resource usage and healthcare quality in Japan. Health Policy. 2012;107(2–3):194–201.
41. Simborg DW. DRG creep: a new hospital-acquired disease. N Engl J Med. 1981;304(26):1602–4.
42. Liang FW, Wang LY, Liu LY, Li CY, Lu TH. Physician code creep after the initiation of outpatient volume control program and implications for appropriate ICD-10-CM coding. BMC Health Serv Res. 2020;20(1):127.
43. Zhang LL, Sun LH. Impacts of Diagnosis-Related Groups Payment on the Healthcare Providers' Behavior in China: A Cross-Sectional Study Among Physicians. Risk Manag Healthc Policy. 2021;14:2263–76.
44. Liao ZY, Zhang YY. Manifestations of Alienation Behaviour Under DRG/DIP Payment and Regulatory Recommendations. China Health Insur. 2023;02:27–34 (in Chinese).
45. Zheng XY, Xiao XY, Shen KY, Pei T, Lin XH, Liu W, Wu D, Meng XH. Impact of Diagnosis-Related Groups (DRG) reform on cost homogeneity of treatment for patients with malignant tumours. Sci Rep. 2024;14(1):21212.
46. Wang YT, Chen Y, Wang JQ, Lao YZ. The impacts of medical insurance payment methods on medical bills and medical service quality: Evidence from Xiangtan. China J Bus Res. 2023;169: 114292.
47. Zhu FM, Wang Z, Fu ZY. Incentive Mechanism and Effect Analysis of DRG Reform. China Health Insur. 2023;02:35–9 (in Chinese).
48. Menke TJ, Ashton CM, Petersen NJ, Wolinsky FD. Impact of an All-Inclusive Diagnosis-Related Group Payment System on Inpatient Utilization. Med Care. 1998;36(8):1126.
49. Wu YS, Fung H, Shum HM, Zhao S, Wong EL, Chong KC, Hung CT, Yeoh EK. Evaluation of Length of Stay, Care Volume, In-Hospital Mortality, and Emergency Readmission Rate Associated With Use of Diagnosis-Related Groups for Internal Resource Allocation in Public Hospitals in Hong Kong. JAMA Netw Open. 2022;5(2):e2145685.
50. Zhang T, Xu Y, Ren J, Sun L, Liu C. Inequality in the distribution of health resources and health services in China: hospitals versus primary care institutions. Int J Equity Health. 2017;16:1–8.
51. Wang YX, Castelli A, Cao Q, Liu D. Assessing the design of China's complex health system–Concerns on equity and efficiency. Health Policy Open. 2020;1:100021.
52. Zhao N, Chen K. Equity and efficiency of medical and health service system in China. BMC Health Serv Res. 2023;23(1):33.
53. Yang Y, Le KJ, Liang C, Zheng T, Gu ZC, Lin HW, Zhang JD, Luo HJ. Changes in inpatient admissions before and during COVID-19 outbreak in a large tertiary hospital in Shanghai. Ann Transl Med. 2022;10(8):469.
54. Li R, Rivers C, Tan Q, Murray MB, Toner E, Lipsitch M. Estimated demand for US hospital inpatient and intensive care unit beds for patients with COVID-19 based on comparisons with Wuhan and Guangzhou. China JAMA network open. 2020;3(5):e208297.
55. Yan YY, Fan TY, Zheng YL, Yang HQ, Li TS, Wang HT, Gu YF, Xiao X, Du ZH, Sun XM. Prevention and control of COVID-19 by primary health care facilities in China: a field-survey-based qualitative study in three typical cities. BMC Health Serv Res. 2022;22(1):399.

Publisher's Note