# RESEARCH

# Did China's hospital reforms improve curative care expenditures? Evidence from Beijing hospitals

Yan Jiang<sup>1+</sup>, Zhaoran Han<sup>1+</sup>, Stephen Nicholas<sup>2,3</sup>, Wanjin Yang<sup>1</sup>, Elizabeth Maitland<sup>4</sup>, Xuefeng Shi<sup>1</sup>, Xiaowei Man<sup>1</sup>, Jianghui Zhao<sup>1</sup> and Wei Cheng<sup>1\*</sup>

# Abstract

**Introduction** To assess whether the comprehensive reforms in 2017 (Reform 1) and 2019 (Reform 2) in Beijing have achieved the anticipated targets by analyzing the changes in curative care expenditure (CCE) and related indicators before and after the reforms.

**Methods** Due to the Covid-19 pandemic, data are not comparable for the period after 2019, we obtained records of patients from the Hospital Information System (HIS) between January 1, 2016 and December 31, 2019. The multistage stratified cluster random sampling was used to obtain sample data, and the System of Health Accounts 2011 was applied to account for the CCE of all hospitals in Beijing. We used an interrupted time series analysis (ITSA) to compare the changes in levels and trends before and after the reforms.

**Results** Overall, the reforms failed to impact the rising trend in CCE, but successfully lowered the level of drug and consumable prices in all hospitals and optimized the hospital revenue structure. The reforms' impact on patient burden was also mixed. For Reform 1, outpatient costs rose in tertiary hospitals, fell for inpatients in tertiary and secondary hospitals, and exhibited no change in all other hospitals. In terms of the trend, Reform 1 saw a fall in patient burden except for a rise inpatients in tertiary and primary hospitals. For Reform 2, the level of total expenditures per outpatient visit fell in primary hospitals, rose per inpatient bed day in secondary hospitals and had no change in all other hospitals. The impact of reforms on Beijing's hierarchical medical system (HMS) was not significant.

**Conclusion** The reform outcomes were only partially in line with the reforms' aims. While echoing the call for more resources for primary hospitals, only major patient medical service pricing changes would shift patients away from tertiary and secondary hospitals towards primary hospitals. We suggest that several measures be taken to enhance the service capacity of primary hospitals and that an advertising campaign be launched to inform and encourage patients to use primary hospitals as gatekeepers.

<sup>†</sup>Yan Jiang and Zhaoran Han contributed to the work equally and should be regarded as co-first authors.

\*Correspondence: Wei Cheng chengwei@bucm.edu.cn

Full list of author information is available at the end of the article



© The Author(s) 2025. **Open Access** This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creative.commons.org/licenses/by-nc-nd/4.0/.





**Keywords** China healthcare reform, Interrupted time series, Curative care expenditure, System of Health Accounts 2011

# Introduction

Healthcare systems world-wide face increasing demands for health services, with the growth in global health expenditures outpacing the growth in global gross domestic product [1]. With an aging population and limited health resources [2–4], China also faces the challenge of increasing curative care expenditures (CCE). China's curative care expenditures accounted for 75.6% of total health expenditures (CHE) in 2012 and 73.4% of Beijing's CHE in 2015 [5, 6], with 95.9% of Beijing's CCE occurring in public primary, secondary and tertiary hospitals [7]. Constraining the growth of CCE is a key part of China's wider reform program to rationalize public hospitals' revenue structures, control health expenditures, reduce the burden on patients and ensure hospital resources are efficiently distributed and equitably accessed.

Before China's health reforms in 2009, the under-funding of public hospitals led hospitals to generate additional income by charging patients mark-ups for drugs, services and consumables, with hospitals earning up to 90% of their budget from revenue-generating activities [8]. The mark-up on medical services, consumables and prescribed drugs incited drug over-prescribing and medical consumables over-use [9-11]. Such mark-ups also imposed a significant healthcare expenditure burden on patients. Compounding these expenditure problems, patients preferred expensive secondary and tertiary hospital treatments over cheaper primary health hospitals, owing to the imbalance in healthcare resources between different hospital levels in China's hierarchical medical system (HMS) [12, 13]. To address these issues, the government legislated a range of health reforms in 2009, including increasing hospital budget al.locations, eliminating the mark-up on drugs and consumables, adjusting service fees and optimizing the hierarchical medical system to support primary hospitals as gatekeepers to secondary and tertiary hospitals [14-16].

As part of China's public hospital reforms, Beijing ended the drug markup and reformed the service fee structure in 2017 (Reform 1) and ended the markup on medical consumables and costs of various services in 2019 (Reform 2). As a pivotal pilot for restructuring public hospital compensation mechanisms in China, Beijing's phased comprehensive healthcare reforms implemented in 2017 and 2019 demonstrate exemplary policy significance. The sequential introduction of the Medicine Separation Reform and Medical Consumables Coordination Reform established an innovative "combined policy paradigm". The initial phase systematically eliminated drug markups and established a dynamic adjustment system for medical service fees. The subsequent phase pioneered a zero markup policy of medical consumables and created a price linkage adjustment matrix of medical service items [17]. The experience accumulated by the pilot in Beijing has important policy diffusion value for deepening the reform of the medical supply side, and offers critical insights for assessing China's healthcare reform [18, 19].

Reform 1 adjusted the prices of medical services by type of hospital and reduced the inflated prices of drugs and equipment, with the aim of reducing public hospitals' heavy reliance on drug sales for income, curbing rising medical expenditures for patients and promoting the first-use of primary health care services. Eliminating the previous registration and consultation fees system, Supplementary Table 1 sets out Reform 1's new medical service fee and health insurance reimbursement schedules to compensate hospitals for the abolition of drug and equipment mark-ups, to reflect the true value of medical staff and to rationalize the use of the HMS. Reform 1 set the medical service fee for general outpatient services at RMB50 for tertiary hospitals, RMB30 for secondary hospitals and RMB20 for primary hospitals, while the basic out-of-pocket payment for tertiary, secondary and primary hospitals after reimbursement through health insurance was RMB10 for tertiary hospitals, RMB2 for secondary hospitals and RMB1 for primary hospitals. The differential service fee and insurance reimbursement policy aimed to channel patients with general and chronic diseases to primary hospitals [20, 21], which acted as gatekeepers to secondary and tertiary hospitals.

Reform 2 abolished the 5–10% mark-up policy for medical consumables; reduced the prices on medical equipment testing items; increased the price of traditional Chinese medicine, pathology, rehabilitation, psychiatry, nursing, and surgical procedures to better reflect the value of medical staff's technical labor; and centralized the procurement of drugs and consumables [22]. For Beijing, the two reforms aimed to establish a sustainable funding mechanism for public hospitals; to adjust the drug and consumables cost structure; and to reduce inflated healthcare expenditures. The reforms also aimed to shift patient preference towards cheaper primary hospitals, enhancing the gatekeeper role of primary health facilities by reducing tertiary and secondary hospitals as patients' first choice for health care [23].

Previous studies have assessed China's health reforms on specific medical institutions, such as public hospitals [20, 24, 25], community health centers [26], traditional

Chinese medicine hospitals [8], and particular groups of patients and patients with different types of illnesses, such as coronary heart disease and non-communicable diseases [27, 28], generally concluding that the reforms reduced hospitals' reliance on drug sales, guided patients to primary healthcare institutions, controlled medical expenditures, reshaped and optimized hospital revenue structure and better reflected the professional value of physicians. But previous studies on Beijing's two healthcare reforms relied on small or incomplete samples, did not evaluate the two reform effects together and did not assess all types of medical institutions, diseases and patients. Addressing these shortfalls, we evaluate the impact of Reform 1 and Reform 2 together for all types of treatments, for all patients in all types and levels at both public and private hospitals in Beijing.

# **Materials and methods**

#### Data sources

Our 2016–2019 data were drawn from both primary and secondary sources: *Beijing Health Financial Statistical Yearbook*, the *Beijing Health Statistical Yearbook*, and the *Beijing Health Accounts Report*, providing data on revenues, subsidies, health insurance reimbursements and service volumes for all public and private hospitals in Beijing. We extracted monthly primary data from Beijing's Hospital Information System (HIS), including information on the hospital level, dates of hospital visits, main disease diagnosis, treatment fees and costs of drugs and hospital supplies. Due to the Covid-19 pandemic, data are not comparable for the period after 2019.

# **Definitions and hypotheses**

Curative care expenditures refer to expenditures on therapeutic supplies and services consumed to restore, maintain and improve patients' health conditions (excluding preventive services) in Beijing's hospitals during one month for both Beijing residents and non-Beijing patients. Consistent with the objectives of the reforms, our outcome indicators were classified into three CCE related categories: expenditures (outpatient and inpatient CCE and the drug proportion and the consumables proportion of CCE); patient burden (total expenditures per outpatient visit and total expenditures per inpatient bed day); and service volume (number of outpatient visits and number of inpatient bed days). CCE is the total of outpatient CCE and inpatient CCE; outpatient CCE is the total expenditures per outpatient visit multiplied by the number of outpatient visits; inpatient CCE is the total expenditures per inpatient bed day times the number of bed days; and the outpatient drug proportion is outpatient drug sales divided by outpatient CCE; and outpatient consumables proportion is revenue from outpatient medical consumables divided by outpatient CCE.

Reform 1 and Reform 2 had several aims. The first aim was to implement a new funding model on hospitals by reforming the hospital revenue structure. Second, Reform 1 also aimed to reduce the proportion of drug costs in CCE and Reform 2 aimed to reduce the proportion of consumables in CCE. Moreover, the reforms aimed to lower CCE and the patients' health expenditure burden. While Reform 1 and Reform 2 aimed to reduce the expenses of outpatient and inpatient care by reducing the drug proportion and consumable proportion of CCE at all hospital levels, the reforms' new medical service fees and health insurance schedules also raised healthcare prices. The net effect of Reform 1 and Reform 2 on the level and trend of hospital expenditures and patient burden is unclear. Finally, both reforms aimed to shift patients away from tertiary and secondary towards primary hospitals.

# Sample hospitals

Supplementary Table 2 shows the number of Beijing hospitals by level included in our CCE accounting every year. We collected data on all 22 municipal-level hospitals, due to the significant differences among municipal-level hospitals in Beijing, and sampled the other government affiliation level hospitals. All hospital levels were sampled from four representative Beijing districts (Dongcheng, Fengtai, Changping, and Pinggu) by using multistage stratified cluster random sampling [2]. The sample comprised 81 hospitals, including 39 public hospitals, 13 socially run hospitals, and 29 primary hospitals. Defined by bed capacity, location, and functional orientation, Supplementary Table 3 displays the sample hospitals on primary hospitals (mainly community health centers), secondary hospitals (providing comprehensive health services) and tertiary hospitals (providing highlevel, specialized and nation-wide health services) by ownership (public and private hospitals) and type (General, Traditional Chinese Medicine and Specialist). To ensure comparability across the 2016-2019 period, the sample hospitals were kept constant. From the surveyed hospitals, the records of about 320 million patients were obtained from HIS between January 1, 2016 and December 31, 2019, containing information on age, sex, primary diagnosis, residency (Beijing resident or not), and medical costs (costs of examination, treatment services, drugs, lab services and consumables). Only aggregated cost data and no patient-specific information were collected, which did not require ethics approval.

The raw data in the sample library is cleaned using three main methods: deletion, patching and logical checking. Firstly, the fields in the sample library where all the cost information is 0 or null are deleted. Secondly, for some of the fields with empty data, they will be supplemented through original data search and mutual verification of field information, and if the data cannot be supplemented, they will be deleted. Thirdly, the cost data of the case library are logically checked according to the following two rules: the first rule is that the drug revenue is greater than or equal to the sum of the revenues of western drugs, proprietary Chinese medicines, and Chinese herbal medicines. The second rule is that the total revenue is greater than or equal to the sum of the revenues from drugs, health materials, and the rest of the revenues. If the logical check conditions are not met and the data cannot be made up, the corresponding data will be deleted. After data cleaning of the original sample database, except for the slightly higher outpatient sample database in 2017, the number of fields deleted from the outpatient and inpatient sample databases in each year was less than 5%, and the loss of information in the sample databases was small, while the quality of inpatient data was higher than that of outpatient (Supplementary Table 4).

# Statistical analysis

We used SHA2011, a global standard for the construction of national health accounts [29], to calculate CCE comprising treatment service fees, drug fees, consumable fees and examination and laboratory tests fees at Beijing's different level hospitals. To obtain the CCE and monthly related indicators at the aggregate level, the top-down accounting methods of SHA2011 were used. First, the total CCE and related indicators at different levels and types of hospitals, such as the drug revenue of all hospitals in Beijing, were obtained from the secondary data. In the second step, the monthly CCE, drug revenue, and other related indicators and their composition in the same year at different levels and types of hospitals were drawn from the primary data. In the third step, the proportion estimates for different levels and types of hospitals were calculated by applying the data in the second step to the total CCE and related indicators obtained in the first step. Finally, the composition of CCE by month at different levels and types of hospitals was calculated. The CCE at different types of hospitals within the same level was aggregated as required.

After collecting the relevant outcome indicators at multiple time points before and after the implementation of Reform 1 and Reform 2, we constructed monthly measurements from January 2016 to December 2019. Based on the three stages of pre-Reform (January 2016-March 2017), Reform 1 (April 2017-June 2019), and Reform 2 (July 2019-December 2019), interrupted time series analysis (ITSA), a quasi-experimental research design, was used to evaluate the reform impacts by comparing outcomes after the two reforms with counterfactual outcomes or outcomes that would have occurred had there been no Reform 1 and Reform 1 but no Reform 2. The outcome model was:

$$\begin{split} Y_t = \beta_0 + \beta_1 \cdot \text{time} + \beta_2 \cdot \text{reform} 1 + \beta_3 \cdot \text{time after reform} 1 + \\ \beta_4 \cdot \text{reform} 2 + \beta_5 \cdot \text{time after reform} 2 + \epsilon_t \end{split}$$

where  $Y_t$  represents the outcome variable; *time* is a linear time variable, representing the time observation point calculated from the beginning of the time series (January 2016), coded from 1, to estimate the baseline trend; reform1 and reform2 are dummy variables representing the reform stage at the observation point, coded as "0" before the reform and "1" after the reform; time after reform1 and time after reform2 are continuous variables counting the number of months after the policy implementations, which was set at "0" before the policy change, and "1" after the policy change, to estimate the change in trend (slope) during the post-reform1 and post-reform2 policy periods.  $\beta_0$  is a constant term, which is the baseline level of the indicators;  $\beta_1$  is the estimator of the trend before the reforms were implemented;  $\beta_2$  and  $\beta_4$  are the estimators of the level change of the outcome variables immediately after the reform implementation;  $\beta_3$  and  $\beta_5$ are the estimators of the trend change in outcome values due to the Reform 1 and Reform 2; and  $\varepsilon_t$  is the random error. A *p-value* < 0.05 was considered statistically significant. The data were tested for seasonality, and the model was adjusted when there was a significant seasonal trend. All the statistical analyses were performed using STATA/ MP 17.0.

# Results

# **Descriptive statistics**

Table 1 summarizes the descriptive results of Beijing's hospitals by period and hospital level. After the implementation of Reform 1, the drug proportion at all types of hospitals declined, achieving a major goal of Reform 1. However, the average monthly CCE at all levels of hospitals increased, the total expenditures per outpatient visit and total expenditures per inpatient bed day at all hospital levels increased, except for inpatients in secondary hospitals, which indicates the net effect of Reform 1 did not decrease expenditures or the patient burden. After Reform 1, the number of outpatient visits in primary and secondary hospitals increased, while visits to tertiary hospitals decreased, supporting the gatekeeper role of primary hospitals and shifting patients away from tertiary hospitals. After Reform 2, the consumables proportion decreased at all hospitals, which was a major aim of the reform. There was a mixed result in terms of the net impact on expenditures and patient burden, with the average monthly CCE increasing, except for outpatients in primary hospitals, and the total expenditures per inpatient bed day increasing while total expenditures

	Primary hos	pital			Secondary	hospital			Tertiary ho	ospital		
	Reform-1		Reform-2		Reform-1		Reform-2		Reform-1		Reform-2	
	Before 2016.01 to	After 2017.04	Before 2018.07	After 2019.07	Before 2016.01	After 2017.04	Before 2018.07	After 2019.07	Before 2016.01	After 2017.04	Before 2018.07	After 2019.07
	2017.03	to 2018.06	to 2019.06	to 2019.12	to 2017.03	to 2018.06	to 2019.06	to 2019.12	to 2017.03	to 2018.06	to 2019.06	to 2019.12
Outpatient												
CCE (million RMB)	66.696	1420.07	1912.40	1815.17	2831.66	3183.78	3416.43	3706.96	3905.55	4108.58	4405.03	4724.51
Drug proportion (%)	86.36	81.98	81.96	81.55	59.85	51.04	47.99	49.13	54.45	47.02	45.52	44.91
Consumables proportion (%)	I	ı	ı	ı	3.71	4.08	4.26	4.05	4.64	5.11	5.25	4.95
Total expenditures per outpatient visit (RMB)	233.31	295.47	327.78	318.41	402.47	444.60	486.20	467.73	536.10	602.77	621.69	620.16
Number of outpatient visits (thousand)	4157.54	4806.09	5834.49	5700.80	7035.74	7160.95	7026.79	7925.40	7285.11	6816.17	7085.55	7618.20
Inpatient												
CCE (million RMB)	18.15	22.64	24.55	27.01	2048.31	2269.23	2660.10	2832.00	4538.38	4960.95	5315.12	5846.71
Drug proportion (%)	40.13	29.35	30.20	31.35	34.16	27.07	27.06	25.94	32.16	25.80	25.49	23.99
Consumables proportion (%)	I	ı	ı	ı	20.54	21.59	22.55	22.45	37.79	37.17	39.60	35.52
Total expenditures per inpatient bed day (RMB)	418.42	561.29	554.44	710.01	1452.96	1448.58	1680.16	1886.01	2623.52	2711.62	3097.17	3230.59
Number of inpatient bed days (thousand)	43.37	40.34	44.28	38.05	1409.76	1566.52	1583.24	1501.58	1729.88	1829.51	1716.12	1809.80

per outpatient visit fell. The number of outpatient visits in primary hospitals dropped, while tertiary hospitals' outpatient visits rose, the opposite of the planned shift in patients from tertiary to primary hospitals.

Table 1 presents the operational status of different hospital types across distinct time periods. It should be noted that the observed data variations reflect not only the effects of the policy under investigation, but also the compounded influences of other contemporaneous policies, including price fluctuation factors, healthcare pricing reforms and other relevant policies.

# Interrupted time series analysis results

The ITSA results in Table 2 show the significant rises or falls or no significant change in the level and trend in the outcome variables due to the two reforms, with the detailed ITSA results reported in Supplementary Table 5.

As shown in Table 2; Fig. 1, the two healthcare reforms had no significant level or trend change on monthly CCE, except Reform 1 saw a fall in the CCE level of inpatients in secondary hospitals and in primary hospitals Reform 2 saw a fall in the outpatient CCE level and a rise in the inpatient CCE trend. ITSA results in Fig. 2; Table 2 show that the level of the drug proportion fell at all hospitals after Reform 1. The trend in outpatient and inpatient drug proportions was mixed, rising for outpatients in tertiary hospitals, inpatients in secondary hospitals and outpatients and inpatients in primary hospitals, otherwise, there was no change. Given the extremely small percentage of consumables in primary hospitals (less than 5% in most years), we only analyzed consumables in secondary and tertiary hospitals. Table 2; Fig. 3 show that the level of the consumable proportion fell at all hospitals, except inpatients at secondary hospitals, but had no change on the consumable proportion trend.

The patient burden in Table 2; Fig. 4 also presents a mixed pattern. For Reform 1, the impact on the level of outpatient costs rose for tertiary hospitals and inpatient costs fell for tertiary and secondary hospitals, and other burden on all other patients had no change. Reform 1 had a significant, but inconsistent, impact on the patient burden trend. The outpatient burden trend fell in tertiary, secondary hospitals, but rose for tertiary and primary hospital inpatients. Reform 2 had a differential impact on patient burden across hospital levels where the total expenditures per outpatient visit fell in primary hospitals, but total expenditures per inpatient bed day rose in secondary hospitals. Reform 2 made no change to the patient burden trend.

Finally, Table 2; Fig. 5 display no change in the level of hospital visits after Reform 1 or Reform 2, except primary outpatients, which fell after Reform 2. Similarly, there

Hospital level	Outcome indicators	Level Change		Change in Trend	
		Reform1	Reform2	Reform1	Reform2
	Expenditures				
Tertiary	Outpatient CCE (million RMB)	No change	No change	No change	No change
	Inpatient CCE (million RMB)	No change	No change	No change	No change
	Outpatient drug proportion (%)	Fall	-	Rise	-
	Inpatient drug proportion (%)	Fall	-	No change	-
	Outpatient consumables proportion (%)	-	Fall	-	No change
	Inpatient consumables proportion (%)	-	Fall	-	No change
Secondary	Outpatient CCE (million RMB)	No change	No change	No change	No change
	Inpatient CCE (million RMB)	Fall	No change	No change	No change
	Outpatient drug proportion (%)	Fall	-	No change	-
	Inpatient drug proportion (%)	Fall	-	Rise	-
	Outpatient consumables proportion (%)	-	Fall	-	No change
	Inpatient consumables proportion (%)	-	No change	-	No change
Primary	Outpatient CCE (million RMB)	No change	Fall	No change	No change
	Inpatient CCE (million RMB)	No change	No change	No change	Rise
	Outpatient drug proportion (%)	Fall	-	Rise	-
	Inpatient drug proportion (%)	Fall	-	Rise	-
	Outpatient consumables proportion (%)	-	-	-	-
	Inpatient consumables proportion (%)	-	-	-	-
	Patient burden				
Tertiary	Total expenditures per outpatient visit (RMB)	Rise	No change	Fall	No change
	Total expenditures per inpatient bed day (RMB)	Fall	No change	Rise	No change
Secondary	Total expenditures per outpatient visit (RMB)	No change	No change	Fall	No change
	Total expenditures per inpatient bed day (RMB)	Fall	Rise	Fall	No change
Primary	Total expenditures per outpatient visit (RMB)	No change	Fall	Fall	No change
	Total expenditures per inpatient bed day (RMB)	No change	No change	Rise	No change
	Service				
Tertiary	Number of outpatient visits (thousand)	No change	No change	No change	No change
	Number of inpatient bed days (thousand)	No change	No change	No change	No change
Secondary	Number of outpatient visits (thousand)	No change	No change	No change	No change
	Number of inpatient bed days (thousand)	No change	No change	No change	No change
Primary	Number of outpatient visits (thousand)	No change	Fall	No change	No change
	Number of inpatient bed days (thousand)	No change	No change	Fall	No change

Table 2 Change in levels and trends of expenditures, drugs, consumables, patient burden and visits

was no change in the trend for hospital visits, except Reform 1 primary inpatients which fell.

## Discussion

Beijing's 2017 and 2019 medical reforms aimed to change the funding models for public hospitals, control the rapid growth of healthcare expenses, especially for drugs and consumables, shift patients from over-used tertiary and secondary to under-used primary hospitals and reduce the heavy economic burden on patients [30]. The reforms had a mixed success. The first success was to change the revenue structure of the public hospital system, generating revenue from medical services, rather than from the sale of drugs and consumables [8, 20, 27]. The medical consultation service fee adopted a tiered pricing structure aligned with both institutional hierarchy (hospital levels) and doctor seniority, serving as a monetized evaluation mechanism for healthcare providers' technical labor. The introduction of increased physician service fees was designed to offset revenue losses resulting from the elimination of drug and consumable markups, thereby restructuring income composition within the healthcare system [24]. The second success was to lower the level of drug and consumable prices [24, 31, 32]. Before Reform 1 doctors over-prescribe drugs due to the profit motive of mark-ups, but with Reform 1 separating hospital revenues from drug mark-ups, the behavior of drug over-prescription by physicians to enhance their personal and the hospital's income fell [33]. The growing rate of total expenditures per outpatient visit/ per inpatient bed slowed, in line with the reform expectations. These reform outcomes partially reduced the economic burden on some patients.

The reforms had no impact on the trend in CCE. As shown in Figs. 1, 2 and 3, the predicted trend of CCE and the drug and consumable proportion trend were mainly



Fig. 1 Trend in the monthly CCE in different levels of hospitals



Fig. 2 Trend in the drug proportions (%) in different levels of hospitals

the same as the counterfactual trend that assumed no Reform 1 or assumed there was only Reform 1 and no Reform 2. Declining prices for drugs and diagnostic tests, and the increase in health insurance coverage rate increased the demand for healthcare services [34, 35], especially for patients who were not able to access health care previously because of high drug and medical services prices. Increasing demand for health care services contributed significantly to the growth in CCE. Rising prices for non-drug and non-consumable services



Fig. 3 Trend in the consumables proportions (%) in different levels of hospitals



Fig. 4 Trend in the total expenditures per outpatient visit/ per inpatient bed day in different levels of hospitals



Fig. 5 Trend in the monthly number of outpatient visits / number of inpatient bed days in different levels of hospitals

with stringent demands for advanced medical technology and additional expenditures on traditional Chinese medicine, which was not consistent with Reform 1 [8, 36], also contributed to higher CCE. Reform 1 outcomes also reflected the specific funding characteristics at different hospital levels. For example, the drug proportion for outpatients in primary hospitals was relatively high, and the immediate decline in the drug proportion after Reform 1 was relatively small when compared with other hospital levels. This can be attributed to the cancellation of some common drug mark-up in primary hospitals in 2006 and the implementation of the drug zero mark-up policy occurring first in primary hospitals in 2009 [37, 38], which meant only a small number of drugs in primary hospitals had a mark-up, explaining why Reform 1 had little impact on the outpatient of primary hospitals.

These CCE and drug and consumable proportion reform outcomes were also reflected in the level of patient burden. Reform 1 was successful in promoting the falls in inpatient and outpatient expenditures, except the rising trend in tertiary and primary inpatient burden. There are two possible reasons for this phenomenon: increased patient demand for medical services after price adjustments and the HMS coming into play. Patients with minor illnesses were seen in primary hospitals patients, receiving more service-oriented medical services, such as nursing care, and patients with serious illnesses were treated in tertiary hospitals, receiving more highly technical medical services, both incurring costs that were priced higher in Reform 1 [39, 40]. The fall in the level of total expenditures per inpatient bed day at secondary and tertiary hospitals was correlated with the elimination of drug mark-ups. After Reform 1, the trend in total expenditures per outpatient visit fell, also related to a change in doctors' over-prescription and over-servicing behavior [34]. In particular, for patients requiring sustained, high-volume consumption of pharmaceuticals and medical consumables due to disease conditions, the economic burden was alleviated through the implementation of these two reforms. We recommend that future policy formulation should prioritize healthcare affordability across diverse population groups, optimizing health financing and insurance designs to better reflect real-world variations.

The aim of China's HMS was to guide self-paying and chronically ill patients away from tertiary and secondary hospitals to primary hospitals. The impact of the reforms on the service load on HMS was not significant, with 'no change' dominating the level and trends in hospital visits in Table 2. The fall in the level of primary hospital outpatient visits and the fall in the trend of inpatient visits were the opposite of the reform aims of strengthening the HMS. There is evidence that the number of visits and the 'no change' in the total expenditures at tertiary hospitals reflected the increase in difficult, acute and severely ill patients attending tertiary hospitals [41, 42]. First, the promotion of tiered healthcare delivery has fallen short of expectations, with patient backflow emerging after the 2019 reform. Tertiary hospitals had more testing equipment and

used more consumables, so when Reform 2 reduced these prices for patients, the attractiveness of tertiary hospitals rose [43, 44], reducing the number of patients referred to primary or secondary hospitals. Second, although price leverage temporarily redirected medical service utilization, the inadequacies in primary care institutions' service capacity, including medical equipment, technical expertise, and service quality, have failed to meet patients' demand for high-quality care. This persistent quality gap makes many patients still prefer to choose tertiary hospitals, undermining the effective operation of the "grass-roots first diagnosis" mechanism [27, 45]. Besides, the dysfunctional two-way referral mechanism further weakens the system, as evidenced by patients' reluctance to transfer from tertiary hospitals to primary institutions, resulting in insufficient "upper and lower linkage" within the healthcare hierarchy [45]. An experimental economics study reveals that different medical insurance payment methods (such as pay-per-item, total prepayment, etc.) significantly influence physicians' service provision behaviors. These behavioral variations may drive patients' institutional preferences under different payment schemes, creating additional implementation barriers for tiered healthcare delivery [46].

Our more comprehensive data on the number of hospitals and inclusion of non-resident Beijing patients helps explain the mixed outcomes for the reforms and different results from existing studies, especially with regard to the HMS results. The hospitalization of non-Beijing patients accounted for nearly 30% of total services between 2016 and 2019 [47], where 41.4% of CCE in 2019 was attributable to non-Beijing patients in Beijing's tertiary hospitals [23]. Tertiary hospitals in Beijing attract a substantial proportion of non-Beijing patients with severe conditions, while community hospitals primarily cater to local residents, particularly elderly patients [2]. Requiring more comprehensive and specialized health services, non-Beijing patients suffered from serious and difficult medical conditions that could not be treated at their primary, secondary and tertiary home province hospitals [23, 48], explaining non-Beijing residents seeking high quality medical treatment in Beijing's tertiary hospitals. A study by Zhou et al. found that health seeking behavior was strongly associated with basic health insurance, chronic diseases, economic level, and educational status [49]. Residents with basic health insurance tended to go to primary hospitals when they were ill with common and chronic diseases [50]. Due to regional disparities in healthcare reimbursement policies, non-local patients seeking care in Beijing face distinct insurance coverage patterns and reimbursement rates compared to local residents. These differentials may create reimbursement barriers for some patients from other regions, consequently Page 10 of 13

influencing their healthcare-seeking behaviors [51]. HMS policies, health insurance payments and the adjustment of medical prices had a greater impact on the local residents' health seeking behavior, but had less effect on non-Beijing health seeking behavior, which helps explain why the impact of reforms on Beijing's HMS was not significant in our study. Future policy formulation should prioritize addressing inter-regional medical insurance reimbursement, with concerted efforts to eliminate existing reimbursement barriers across administrative boundaries.

Our results suggest the following recommendations. To address the rising service volume at tertiary hospitals and the decline in primary hospitals, there is ample research recommending improving the service capacity and technical level of primary and secondary hospitals to better attract patients and promote the HMS [14, 25, 49, 52]. This recommendation has been acted on by health officials with primary hospital government grants rising from 21.09 to 24.22% (2018-2021) of the Beijing hospital budget [53]. Despite these funding rises, the quality and funding gap between Beijing's hospital levels remains. The gap between the quality of tertiary, secondary and primary hospitals is unlikely to be addressed by further service fee and insurance reform since these further reforms would require the difficult choice to raise service fees and reduce insurance reimbursements severely impacting the economically most disadvantaged patients [54]. It is imperative to enhance the service capacity of primary healthcare institutions to effectively achieve the objectives of hierarchical diagnosis and treatment. Specifically, this involves strengthening financial support mechanisms to facilitate equipment upgrading and technological advancement, while simultaneously implementing specialized training programs for healthcare professionals. Innovative incentive policies should be developed to encourage talent flow, establishing mechanisms that link professional title promotions with grassroots services [55, 56]. Additionally, the dual integration model of technology and personnel from tertiary hospitals should be deepened, leveraging telemedicine collaboration networks and institutionalized expert residency support programs to systematically improve the service capabilities of primary hospitals. Furthermore, the government needs to change patients' healthcare seeking behavior, perhaps through an advertising campaign emphasizing the gatekeeper role of primary hospitals.

Our study has several limitations. First of all, since our data for Reform 2 are only available for six months, the long-term effects of Reform 2 policies, such as centralized procurement, need further study. Second, we used the drug and consumables proportion to explore the impact of the reforms on hospitals' revenue structure, but we lacked other indicators, such as the share of revenue from medical examinations, surgeries, diagnostics, and medical services, which future studies should consider. Third, since interrupted series data require precision to the monthly level, the continuous subdivision of the sample data may lead to its decreasing precision. Fourth, the impact of the two reforms on patients' out-ofpocket costs could not be effectively estimated because of inadequate health insurance reimbursement information in the sample data. Although we have the advantage of sample representation, our results only represent Beijing hospitals, so we remain cautious about extrapolating the results to other cities and provinces without further studies.

# Conclusion

To assess the effect of the two healthcare reforms launched in Beijing in 2017 and 2019, we used the descriptive results and an interrupted time series model to analyze relevant data from a representative sample of all hospitals in Beijing. At best, the reforms had a modest or no impact on CCE, patient burden and service levels, but successfully adjusted public hospitals' revenue structure. The impact of reforms on Beijing's hierarchical medical system (HMS) was not significant. Consistent with the aims of Reform 1, the decrease in the level of the drug proportion at all hospitals and total expenditures per inpatient bed day at secondary and tertiary hospitals was significant. A slower growing trend in total expenditures per outpatient visit at all levels of hospitals marked a significant achievement for Reform 1. Reform 1 had no significant impact on the service volume level or trend, which means a major reform aim of shifting patients from secondary and tertiary to primary hospitals was unsuccessful. After Reform 2, the consumables proportion level mainly fell across all levels of hospitals, but there was no change in the CCE trend and little or no impact on the level or trend of patient burden or service volume. We recommend strengthening the capacity of the primary hospital, rationalizing the layout of highquality medical resources in Beijing and continuing to control the rise on CCE.

#### Abbreviations

- CCE Curative care expenditure
- HIS Hospital information system
- ITSA Interrupted time series analysis
- CHE Curative care expenditures
- HMS Hierarchical medical system

## **Supplementary Information**

The online version contains supplementary material available at https://doi.or g/10.1186/s12913-025-12785-8.

Supplementary Material 1.

#### Page 11 of 13

#### Acknowledgements

We thank the Beijing Municipal Health Commission for their support of the data collection efforts.

#### Authors' contributions

JY and HZR contributed equally. CW designed and supervised the project. JY and HZR drafted the manuscript. JY, HZR, SN, YWJ, EM, SXF, and MXW critically reviewed and edited the manuscript. SN, EM, ZJH provided language support. All authors have read and approved the final manuscript.

#### Funding

This work was supported by the Beijing Municipal Health Commission (BUCM-2021-kJ-GL006).

#### Data availability

The data that support the findings of this study are available from Beijing Municipal Health Commission but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the author (contact Yan Jiang) upon reasonable request and with permission of Beijing Municipal Health Commission.

#### Declarations

#### Ethics approval and consent to participate

Not applicable.

The study was supported by the Beijing Municipal Health Commission. The patient identification data was anonymized, so the ethical committee approval was not required.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

#### Author details

<sup>1</sup>School of Management, Beijing University of Chinese Medicine, No.11 North 3rd Ring Road East, Chaoyang District, Beijing, China <sup>2</sup>Health Services Research and Workforce Innovation Centre, Newcastle Business School, University of Newcastle, Newcastle, NSW, Australia <sup>3</sup>Australian National Institute of Management and Commerce, Sydney, NSW, Australia

<sup>4</sup>School of Management, University of Liverpool, Liverpool, UK

Received: 8 July 2024 / Accepted: 22 April 2025 Published online: 01 May 2025

#### References

- WHO. Global expenditure on health: public spending on the rise? Geneva: World Health Organization; 2021.
- Jiang Y, Man X, Shi X, Zhao L, Yang W, Cheng W. Who consumes curative care expenditure of medical institutions in Beijing: a case study based on system of health accounts 2011. BMC Health Serv Res. 2023;23(1):548.
- Fang EF, Xie C, Schenkel JA, Wu C, Long Q, Cui H, et al. A research agenda for ageing in China in the 21st century (2nd edition): focusing on basic and translational research, long-term care, policy and social networks. Ageing Res Rev. 2020;64:101174.
- Yang G, Wang Y, Zeng Y, Gao GF, Liang X, Zhou M, et al. Rapid health transition in China, 1990–2010: findings from the global burden of disease study 2010. Lancet. 2013;381(9882):1987–2015.
- Chai P, Zhang Y, Wan Q, Guo F, Zhai T, Wang C, et al. Estimation results of China curative care expenditure based on SHA 2011. Chin Health Econ. 2015;34(03):17–9.
- Zhao L, Zhao X, Jiang Y, Man X, Li B, Wang W, et al. The results of curative care expenditure of Beijing based on SHA 2011. Chin Health Econ. 2018;37(02):27–9.

- Man X, Zhao X, Jiang Y, Zhao L, Wang W, Li B, et al. The accounting results of current health expenditure of Beijing district based on SHA 2011. Chin Health Econ. 2018;37(02):18–23.
- Zhu D, Shi X, Nicholas S, Bai Q, He P. Impact of China's healthcare price reforms on traditional Chinese medicine public hospitals in Beijing: an interrupted time-series study. BMJ Open. 2019;9(8):e029646.
- 9. Yip WC, Hsiao WC, Chen W, Hu S, Ma J, Maynard A. Early appraisal of China's huge and complex health-care reforms. Lancet. 2012;379(9818):833–42.
- Meng Q, Yin D, Mills A, Abbasi K. China's encouraging commitment to health. BMJ. 2019;365:l4178.
- 11. Yang C, Shen Q, Cai W, Zhu W, Li Z, Wu L, et al. Impact of the zero-markup drug policy on hospitalisation expenditure in Western rural China: an interrupted time series analysis. Trop Med Int Health. 2017;22(2):180–6.
- 12. Liu GG, Vortherms SA, Hong X. China's health reform update. Annu Rev Public Health. 2017;38:431–48.
- 13. Xu J, Mills A. 10 years of China's comprehensive health reform: a systems perspective. Health Policy Plann. 2019;34(6):403–6.
- 14. Ma X, Wang H, Yang L, Shi L, Liu X. Realigning the incentive system for China's primary healthcare providers. BMJ. 2019;365:12406.
- 15. Xu J, Jian W, Zhu K, Kwon S, Fang H. Reforming public hospital financing in China: progress and challenges. BMJ. 2019;365:14015.
- Meng Q, Mills A, Wang L, Han Q. What can we learn from China's health system reform? BMJ. 2019;365:I2349.
- 17. Lin Y, Li L, Liu B. Assessing the price levels of medical service and influential factors: evidence from China. BMC Public Health. 2024;24(1):119.
- 18. Qian J. Health reform in China: developments and future prospects. Health Care Sci. 2022;1(3):166–72.
- Xiong W, Deng Y, Yang Y, Zhang Y, Pan J. Assessment of medical service pricing in China's healthcare system: challenges, constraints, and policy recommendations. Front Public Health. 2021;9:787865.
- 20. Liu X, Xu J, Yuan B, Ma X, Fang H, Meng Q. Containing medical expenditure: lessons from reform of Beijing public hospitals. BMJ. 2019;365:12369.
- 21. Beijing Municipal Government. Implementation plan for comprehensive reform on separating drug sales from hospital revenues. 2017.
- 22. Beijing Municipal Government. Implementation plan for comprehensive reform of medical consumables linkage on medical income. 2018.
- Jiang Y, Man X, Zhao L, Cai D, Liu L, Cheng W. Analysis on the composition of the beneficiaries of medical institutions between residents and Nonresidents under the comprehensive reforms in Beijing. Chin Health Econ. 2022;41(07):32–6.
- 24. Gao L, Shi L, Meng Q, Kong X, Guo M, Lu F. Effect of healthcare system reforms on public hospitals' revenue structures: evidence from Beijing, China. Soc Sci Med. 2021;283:114210.
- Zhou S, Xu J, Ma X, Yuan B, Liu X, Fang H, et al. How can one strengthen a tiered healthcare system through health system reform? Lessons learnt from Beijing, China. Int J Environ Res Public Health. 2020;17(21):8040.
- Zhang X, Chen L-W, Mueller K, Yu Q, Liu J, Lin G. Tracking the effectiveness of health care reform in China: a case study of community health centers in a district of Beijing. Health Policy. 2011;100(2–3):181–8.
- Liu L, Xu Y, Jiang Y, Zhao L, Yin X, Shen C, et al. Impact of Beijing healthcare reform on the curative care expenditure of outpatients with noncommunicable diseases based on SHA2011 and interrupted time series analysis. BMC Health Serv Res. 2021;21(1):1045.
- Liu L, Xu Y, Yu J, Man X, Jiang Y, Zhao L, et al. The impact of comprehensive public hospital reforms on the direct medical cost of inpatients with coronary heart disease. Front Public Health. 2022;10:891186.
- Mueller M, Morgan D. New insights into health financing: first results of the international data collection under the system of health accounts 2011 framework. Health Policy. 2017;121(7):764–9.
- 30. Li L, Xiao J, Hou J. Research on the influence of comprehensive medicalpharmaceutical separation and medical-consumables linkage reforms on hospitalization expenses and structure in Beijing: based on the empirical analysis of T hospital. Chin J Health Policy. 2020;13(08):15–22.
- Hu Y, Liang J, Cai Y, Cao X, He S, Wang W. Effect of comprehensive reform of medical-pharmaceutical separation and medicine-consumables linkage on hospital outpatient expenses in Beijing. Med Soc. 2023;36(08):9–15.
- Cai Y, Hu Y, Fan R, Ou Y, Ju L, Wang W. Effect of comprehensive reform of medical-pharmaceutical separation and medicine-consumables linkage on hospital hospitalization expenses in Beijing. Med Soc. 2023;36(08):1–8.
- Li L, Yu Q. Does the separating of hospital revenue from drug sales reduce the burden on patients? Evidence from China. Int J Equity Health. 2021;20(1):12.

- Zhang H, Hu H, Wu C, Yu H, Dong H. Impact of China's public hospital reform on healthcare expenditures and utilization: a case study in ZJ Province. PLoS ONE. 2015;10(11):e0143130.
- 35. Chen J, Xu S, Gao J. The mixed effect of China's new health care reform on health insurance coverage and the efficiency of health service utilisation: a longitudinal approach. Int J Environ Res Public Health. 2020;17(5):1782.
- Zhu Z, Wang J, Sun Y, Zhang J, Han P, Yang L. The impact of zero markup drug policy on patients' healthcare utilization and expense: an interrupted time series study. Front Med (Lausanne). 2022;9:928690.
- Cheng H, Zhang Y, Sun J, Liu Y. Impact of zero-mark-up medicines policy on hospital revenue structure: a panel data analysis of 136 public tertiary hospitals in China, 2012–2020. BMJ Glob Health. 2021;6(11):e007089.
- Wang Z, Chen Y, Wang Z, You C, Feng R, Gong X, et al. Analysis of the phenomon of the shortage of the zero-profit drug supply in the CHS facility. Chin Health Econ. No. 2008;305(07):22–4.
- Chen S, Ye X, Zhu D, Shi X, He P. Lmpact of the comprehensive reform of separating of prescribing and dispensing on hospitalization expenses of public hospital of traditional Chinese medicine in Beijing. Chin Hosp Manage. 2022;42(07):25–9.
- Shu Z, Liu Y, Li M, Li J. The effects of health system reform on medical services utilization and expenditures in China in 2004–2015. Int Health. 2021;13(6):640–7.
- Rong X, Zou Y, Chen L, Zhou J. Analysis on the effect of the medicine separation reform and medical consumables reform on a hospital in Beijing. Chin Med Record. 2020;21(12):54–7.
- 42. Wang R, Deng Y. Analysis and evaluation on the effect of the medical separation reform on a three A and tertiary hospital in Beijing. Chin Med Record. 2020;21(05):42–4.
- Lu F, Wang T, Zang B, Fu H, Guo M. Impacts of comprehensive reforms of clinic-pharmacy separation and medicine-consumables expenditure linkage in Beijing on medical expediture. Chin J Hosp Adm. 2020;36(07):544–8.
- Jiang Y, Man X, Zhao L, Cai D, Liu L, Cheng W. Analysis on the changes of institution flow before and after the comprehensive reform for the treatment costs of paients from different sources in Beijing. Chin Health Econ. 2022;41(08):29–33.
- 45. Gao Y, Guo Y, Deng J. Effects of and prospects for the hierarchical medical policy in Beijin G, China. Healthc (Basel). 2024;11(8):1067.
- Lin S, Sun Q, Zhou H, Yin J, Zheng C. How medical insurance payment systems affect the physicians' provision behavior in China-based on experimental economics. Front Public Health. 2024;12:1323090.
- 47. Jiang Y, Man X, Zhao L, Cai D, Liu L, Cheng W. Analysis on the treatment costs of residents and non-residents in medical institutions before and after the reforms of "medical-pharmaceutical separation" and "medical consumption linkage" in Beijing based on "SHA 2011". Chin Health Econ. 2022;41(07):37–40.
- Liu JJ, Bellamy G, Barnet B, Weng S. Bypass of local primary care in rural counties: effect of patient and community characteristics. Ann Fam Med. 2008;6(2):124–30.
- Zhou Z, Zhao Y, Shen C, Lai S, Nawaz R, Gao J. Evaluating the effect of hierarchical medical system on health seeking behavior: A difference-in-differences analysis in China. Soc Sci Med. 2021;268:113372.
- Zhou Z, Wang C, Yang H, Wang X, Zheng C, Wang J. Health-related quality of life and preferred health-seeking institutions among rural elderly individuals with and without chronic conditions: a population-based study in Guangdong Province, China. Biomed Res Int. 2014;2014:192376.
- Li B, Liang X, Qi X. The effect of health insurance reimbursement rates on middle-aged and elderly People's hospital choices: evidence from China. Health Econ Rev. 2025;15(1):17.
- Cai C, Xiong S, Millett C, Xu J, Tian M, Hone T. Health and health system impacts of China's comprehensive primary health care reforms: a systematic review. Health Policy Plann. 2023;38(9):1064–78.
- 53. Beijing Municipal Health Big Data and Policy Research Center, Beijing Institute of Hospital Management. Beijing health development report. 2021.
- Ta Y, Zhu Y, Fu H. Trends in access to health services, financial protection and satisfaction between 2010 and 2016: has China achieved the goals of its health system reform? Soc Sci Med. 2020;245:112715.
- Lin S, Sun Q, Zhou H, Yin J, Zheng C. How medical insurance payment systems affect the physicians' provision behavior in China-based on experimental economics. Front Public Health. 2024;12:1323090.

 Liang J, Cai Y, Cao X, He Y, He S, Wang W. How medical insurance payment systems affect the physicians' provision behavior in China—based on experimental economics. Med Soc. 2023;36(08):16–21.

# **Publisher's Note**

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.