BMJ Open

Impact of capitation on outpatient expenses among patients with diabetes mellitus in Tianjin, China: a natural experiment

Yanan Dong, Jiageng Chen, Xiyue Jing, Xinjun Shi, Yunfeng Chen, Xiaowei Deng, Changping Li, Jun Ma

Health Statistics, College of Public Health, Tianjin Medical University, Tianjin, China

Correspondence to
Dr Changping Li;
lichangping@tmu.edu.cn

ABSTRACT

Objectives Capitation policy, a new medical insurance settlement method implemented on 1 January 2014 in Tianjin, China, aimed to control unreasonable increases in medical costs. The goal of the current study was to evaluate the impact of capitation on outpatient expenses among patients with diabetes mellitus and provide scientific evidence for health policy-makers.

Design A natural experiment.

Setting The medical insurance database of Tianjin from 1 January 2010 to 31 December 2014.

Participants In total, 35 529 records were included, comprising 9646 records in the pilot group (4907 records in 2014 and 4739 records in 2013) and 25 883 records in the control group (9814 records in 2014 and 16 069 records in 2013).

Main outcome measures The outcome variables included annual total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses.

Results Capitation produced an increase in total outpatient expenses of ¥1993.76 (95% CI, ¥1643.74 to ¥2343.77) in the pilot group relative to the control group. There was also an increase in drug expenses of ¥1904.30 (95% CI, ¥1578.63 to ¥2229.96) after the implementation of capitation. An increase in examination expenses of ¥44.90 (95% CI, ¥19.11 to ¥70.68) was found in the pilot group versus the control group. Capitation also produced an increase in treatment expenses of ¥3.55 (95% CI, ¥1.01 to ¥6.09) and an increase in other expenses of ¥43.46 (95% CI, ¥26.81 to ¥60.11) in the pilot group versus the control group.

Conclusion Compared with those who participated in the 'control' policy, outpatient expenses of patients enrolled in capitation increased significantly. The increases were due to the actual needs of patients, changes in drug directories, and the autonomy and independence of hospitals. It is necessary for the government, policy-makers, hospitals, doctors, patients and supervisory agencies to improve the capitation policy.

INTRODUCTION

Diabetes mellitus (DM), a widespread chronic and non-communicable disease that is rapidly growing in prevalence, is becoming an increasingly serious global public health problem. The latest International Diabetes Federation (IDF)[1] figures show that there were 425 million diabetic patients in the world in 2017, and this number is expected to reach 629 million by 2045. China has a total of 114.4 million patients with DM, the most in the world, and this number is expected to increase to 119.8 million by 2045. Meanwhile, medical expenses for the treatment of diabetes are rapidly increasing. In China, relevant research[2] confirmed that the annual total cost of medical care per diabetic patient increased from ¥4471.61 to ¥8788.52 from 2000 to 2009, remaining approximately four times the cost per non-diabetic patient, which increased from ¥1109.68 to ¥2179.84 during the same period. In 2017, total healthcare expenditure on diabetes was $110 billion in China, second only to the USA.[1]

Diabetes may significantly increase the financial burden for patients and health systems. Paying for service is still the main payment mechanism in China. However, the problem of 'expensive medical costs and

Strengths and limitations of this study

► Few studies have assessed the impact of the capitation policy on medical costs in Tianjin.
► Propensity score matching was performed to create comparable intervention and control groups so that the impact of capitation could be evaluated appropriately.
► We estimated the impact of capitation reform on outpatient expenses among patients with diabetes mellitus through a difference-in-difference analysis to overcome bias caused by preassessments/postassessments.
► Research on the associations among capitation, health outcomes and medical costs is lacking in our study.

poor access to medical care' has not been solved. Therefore, reducing the economic burden for patients with DM is a major challenge in the Chinese health system. Policy-makers are increasingly interested in reducing healthcare costs and inefficiencies through innovative payment strategies.[3] Payment reform is on the political agenda for China's healthcare system. The two major payers in China, the Ministry of Human Resources and Social Security (MOHRSS) and the National Health and Family Planning Commission (NHFPC), issued official documents on payment reform in 2011 and 2012 that identified the use of prospective payment methods, including capitation, as a priority for payment reform.

As the third largest city in China, Tianjin enjoys the same political status as a province. Tianjin is located on the eastern coast of China, where the prevalence of diabetes is the highest.[4] Medical expenses for DM amounted to ¥3300 million, accounting for 80% of the medical expenses for all outpatient special diseases in Tianjin. A capitation policy was implemented as a possible method for controlling unreasonable increase in medical expenses in Tianjin. Capitation payments have also been adopted in Latin America, Thailand and Nigeria.[5] This new medical insurance settlement method has been officially piloted since 1 January 2014 at the ST Hospital in the Tianjin Nankai district. Capitation policy refers to a practice, whereby medical insurance agencies (governmental agencies) pay for medical expenses that are reimbursed at a capitation standard to designated hospitals. Patients' out-of-pocket expenses are settled on the basis of total outpatient expenses and proportion of payment. The agencies do not consider the extent of medical service provided by doctors when they prepay insurance expenses. Agencies and institutions share in the financial risk. The policy enables doctors to provide long-term, 'one-on-one' guidance to patients and establish a long-term mechanism to promote trust in the healthcare system. Doctors guide patients in terms of dietary health and physical activity to prevent premature DM complications. Patients are prescribed not only hypoglycaemic drugs but also drugs for lowering blood pressure, lowering blood lipids and managing DM-related complications. They are scheduled to undergo a routine blood examination every month and glycated haemoglobin (HbA1c) tests every 3 months. In addition, patients can choose 'three hospitals, one drugstore', not just ST Hospital. Furthermore, they are offered referral services to tertiary hospitals based on the patient's condition and complications. The policy also monitors the patient's condition on a regular basis to prevent unreasonable increases in medical costs. The 'outpatient special diseases' medical insurance policy is still implemented in other hospitals for patients with DM. This policy was aimed at patients in a large population who require long-term treatment via hospitalisation and outpatient treatment and incur high medical expenses; 13 diseases and conditions covered in this policy in Tianjin include DM, pulmonary heart disease, cancer, mental disorders, kidney

dialysis, antirejection therapy after renal transplantation, lupus erythematodes, hemiplegic paralysis, antirejection therapy after liver transplantation, haemophilia, epilepsy, aplastic anaemia and chronic thrombocytopenic purpura. The reimbursement ratio of urban employees who participated in the 'outpatient special diseases' policy ranged from 80% to 95% according to different categories of patients (employees, retirees and veteran workers), while that of urban residents ranged from 45% to 65% based on different hospital grades and different categories of patients (students, children and adult residents) in 2017 (online supplementary appendix 1). The remaining ratio was paid out of pocket by patients. These ratios were based on expenses exceeding the annual deductible, which is the amount paid out of pocket for covered expenses before reimbursement.

Few studies have assessed the impact of capitation policy on medical costs in Tianjin. The purpose of this article is to explore the association between capitation and the outpatient costs of diabetes, including annual total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses related to DM, to provide scientific evidence for further improvement of the policy.

METHODS
Study design

ST Hospital, a secondary hospital in the Nankai district of Tianjin, was chosen as the subject of investigation. According to relevant policies, capitation has been implemented since 1 January 2014 in the hospital. The study was not controlled in the traditional sense of a randomised experiment. Participants were exposed to the policy naturally. Thus, the study design was defined as a natural experiment. In this natural experiment, patients with DM who participated in the reform at ST Hospital were in the pilot group, which was compared with a control group of people with DM sampled from the remaining hospitals using the 'outpatient special diseases' insurance policy. Although the policy was only piloted in a secondary hospital, patients could go to hospitals at different levels based on their condition according to the policy. Therefore, records for the control group were not selected from other secondary hospitals but from the remaining hospitals in Tianjin. Capitation fee standards were calculated based on the medical insurance reimbursement ratio of urban employees and urban residents and the average expenses in Tianjin for the previous 3 years:

$$M_i = \left[\bar{X} \times (1 - t) - D_i - G \right] \times S_i \tag{1}$$

In Equation (1), 'i' represents different categories of patients (including employees, retirees, students, children, adult residents, elderly residents), 'M_i' represents capitation fee standards of different categories of patients, '$\bar{X}$' represents annual cost per patient with DM in the last 3 years in Tianjin, 't' represents out-of-pocket proportion,
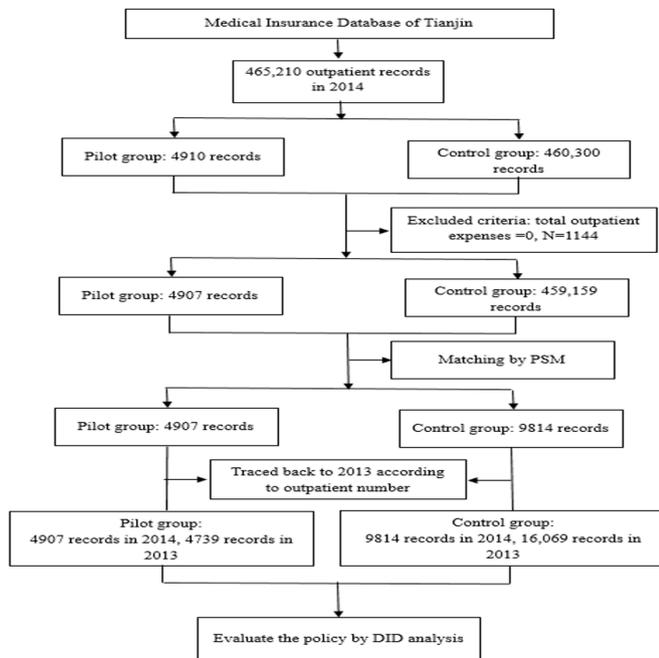
Figure 1 Flow chart of the study participants. Pilot group=patients with DM who participated in the capitation policy; control group=patients with DM who used 'outpatient special diseases' insurance policy. DID, difference-in-difference; PSM, propensity score matching.

'D_i' represents annual deductible, 'G' represents additional payment and 'S_i' represents the reimbursement ratio of 'outpatient special diseases'.

Data source

Data from 1 January 2010 to 31 December 2014 were collected from the medical insurance database of Tianjin. There were 1 850 395 outpatient records with DM. We excluded the records in which total outpatient expenses were equal to 0 and 1 845 022 records remained. We used data from 1 January 2010 to 31 December 2014 to capture trends in outpatient expenses.

Data from this data range were used to evaluate the effects of capitation policy on outpatient expenses. There were 410 620 and 465 210 outpatient records with DM in 2013 and 2014, respectively. In 2014, 4910 records of outpatients who participated in capitation were assigned to the pilot group at ST Hospital. There were 460 300 outpatient records assigned to the control group. The records of total outpatient expenses equal to 0 were excluded. There were 1363 and 1144 records that dropped out in 2013 and 2014, respectively. There were 4907 records that remained in the pilot group and 459 159 records that remained in the control group in 2014 (figure 1). Specifically, a patient can have multiple records in the same year, as hospital grades are considered influential factors in medical costs. Each individual may have a maximum of three records and a minimum of one record every year. Our study was designed according to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Guidelines.

Observations and definitions

Outpatient demographic information (sex, age), disease diagnosis, categories of patients (urban employees and urban residents), hospital level and outpatient expenses were included in the database.

Total outpatient expenses comprised reimbursable expenses (covered by government) and patients' out-of-pocket expenses, which included drug expenses, examination expenses, treatment expenses and other medical expenses related to DM. In terms of drug expenses, patients enrolled in the 'outpatient special diseases' policy can only choose from among 18 Western medicines and 6 proprietary Chinese medicines as hypoglycaemic drugs for medical insurance reimbursement. However, the patients enrolled in capitation policy were not subject to restrictions and were prescribed other drugs for diabetes depending on their condition. Other expenses included bed expenses and medical material expenses, which were merged due to the low cost per item.

We summarised the complications and comorbidities per patient with DM based on disease diagnosis. Based on previous research experience,[6] the comorbidities of the disease can be classified into 29 types (online supplementary appendix 2). Considering the International Classification of Disease, the complications of diabetes were divided into seven types: acute complications, diabetic retinopathy, diabetic nephropathy, diabetic foot, cardiovascular and cerebrovascular disease, diabetic neuropathy and peripheral angiopathy.

Outcome variables

Indicators that were employed to measure the financial impact of capitation included: annual total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses. In sensitivity models, expenses were log-transformed because the distribution of the untransformed variables was heavily skewed.[7]

Statistical analysis

Our exploratory analysis started by analysing the basic characteristics and outpatient expenses of patients based on statistical description. For univariate comparisons, X^2 tests were used to evaluate categorical variables, and t-tests were used for continuous variables. This study examined variations in total outpatient expenses, drug expenses examination expenses, and other expenses from 2011 to 2014 in hospitals with and without capitation by a line chart.

Propensity score matching (PSM) was performed to create comparable intervention and control groups.[8 9] This method allows observational studies to be designed in a manner similar to randomised experiments.[10] Variables including sex, age, number of comorbidities, number of complications, type of medical insurance and hospital grade were used to generate the propensity score. Records from the pilot group and control group were paired 1:2 using nearest neighbour matching, with each record in the pilot group matched to two records in the control group.[8] The PSM balance was evaluated

by comparing standardised differences in the means of matching variables before and after PSM using a threshold of 0.1.[11] The records from 2013 for both groups were traced back according to the outpatient number per patient. Ultimately, there were 9646 records in the pilot group (4907 records in 2014 and 4739 records in 2013) and 25 883 records in the control group (9814 records in 2014 and 16 069 records in 2013) (figure 1).

We estimated the impact of capitation reform on outpatient expenses among patients with DM through difference-in-difference (DID) analysis, which compares mean changes in an outcome in a pilot group before and after a policy change with the mean changes in a control group with no policy change.[12 13] The method can overcome bias caused by preassessments/postassessments.[14] DID analysis was conducted on the matched sample.

The impact of performing capitation is:

$$DID = (y_{pilot,2014} - y_{pilot,2013}) - (y_{control,2014} - y_{control,2013}) \quad (2)$$

In Equation (2), 'y' is the outcome variable (annual health expenses). To control for the observable confounding factors, linear regression models were employed to analyse the impact of capitation policy on outpatient expenses among patients with DM.

$$y = \beta_0 + \beta_1 pilot + \beta_2 year + \beta_3 pilot*year + \beta_i X_i + \varepsilon \quad (3)$$

In Equation (3), 'y' indicates dependent variables (annual health expenses); '$pilot$' and '$year$' indicate independent variables; '$pilot* year$' indicates the interaction term; 'X_i' indicates control variables (including sex, age, number of comorbidities, number of complications, type of medical insurance and hospital grade); and 'ε' indicates the residual term. Although the policy was only piloted in a secondary hospital, patients could be treated at hospitals of different levels for their condition according to the policy. Therefore, hospital grade was incorporated into the model as a covariate.

$$y_{pilot,2014} - y_{pilot,2013} = y_{1,1} - y_{1,0} = \beta_2 + \beta_3 \quad (4)$$

$$y_{control,2014} - y_{control,2013} = y_{0,1} - y_{1,0} = \beta_2 \quad (5)$$

$$(y_{pilot,2014} - y_{pilot,2013}) - (y_{control,2014} - y_{control,2013}) = \beta_3 \quad (6)$$

Therefore, β_3 is the estimate of DID (regression-adjusted DID), and the estimate of β_3 becomes more sophisticated when the control variables are included in Equation (3).[15] Online supplementary appendix 3 explains the definition and assignment of categorical variables.

The variations in trends in median annual total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses were similar in hospitals with and without capitation from 2010 to 2013 (figure 2), which is consistent with the DID hypothesis.[15] Various models were used for the estimate. First, expenses as dependent variables were subsumed into the models directly. Second,
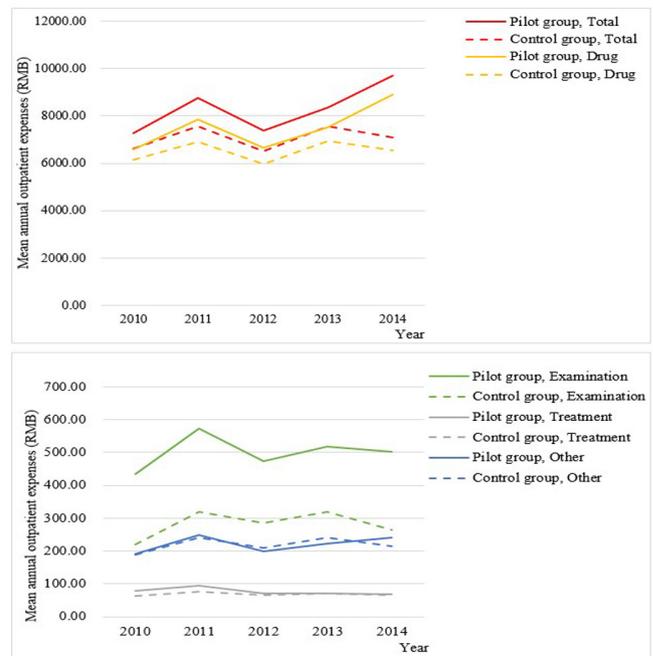

Figure 2 Trends of annual expenses per outpatient in hospitals with and without capitation from 2010 to 2014. From 2010 to 2013, the variations of trends in mean annual total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses between the two groups were similar. The total outpatient expenses, drug expenses and other expenses were increased in the pilot group but decreased in the control group from 2013 to 2014. The decrease in examination expenses and treatment expenses from 2013 to 2014 was less in the pilot group than in the control group. In general, capitation influenced the trends significantly.

log-transformed expenses as dependent variables were subsumed into DID models in a sensitivity analysis because the distribution of the untransformed variables was heavily skewed.[7] Third, the control group was sampled from other secondary hospitals with a ratio of approximately 1:2 using PSM for another sensitivity analysis. Due to the existence of collinearity between the number of comorbidities and the number of complications, only the latter was subsumed into the regression models. A two-sided p value less than 0.05 was considered statistically significant. The data were analysed using SAS V.9.3 software and RGui (R V.3.4.4, platform: x64 Windows OS).

Patient and public involvement
Patients were not involved in setting the research question or the outcome measures. No patients were involved in the study design and recruitment stages or in conducting the study. Additionally, the results of the research were not disseminated to study participants.

RESULTS
Sociodemographic characteristics
A total of 35 529 records (18 936 males, 53.30%) were included in the analysis to assess capitation. Table 1

Table 1 Characteristics of patients with diabetes mellitus between the two groups in 2014 before PSM

Variables	Pilot group (n=4907)	Control group (n=459 159)	P value
Sex, n (%)			<0.001
Male	2650 (54.00)	2 32 450 (50.63)	
Female	2257 (46.00)	2 26 709 (49.37)	
Age (years), mean±SD	62.44±10.69	60.81±10.73	<0.001
Number of comorbidities, n (%)			<0.001
0	1343 (27.37)	179 413 (39.07)	
1	1473 (30.02)	135 287 (29.46)	
≥2	2091 (42.61)	144 459 (31.46)	
Number of complications, n (%)			<0.001
0	1800 (36.68)	229 503 (49.98)	
1	1020 (20.79)	126 591 (27.57)	
≥2	2087 (42.53)	103 065 (22.45)	
Types of medical insurance, n (%)			<0.001
Urban employees	4725 (96.29)	388 182 (84.54)	
Urban residents	182 (3.71)	70 977 (15.46)	
Hospital grade*, n (%)			<0.001
Primary hospitals	1252 (25.51)	158 363 (34.49)	
Secondary hospitals	2678 (54.58)	133 279 (29.03)	
Tertiary hospitals	977 (19.91)	167 517 (36.48)	

*ST Hospital is a secondary hospital, but patients with diabetes mellitus participating in capitation also went to other grades of hospitals as appropriate.
PSM , propensity score matching.

presents the sociodemographic characteristics among patients with DM in 2014 before matching. The average age of patients was 60.83±10.73 years. Compared with hospitals without capitation, patients in ST Hospital were more likely to be male, older, urban employees, suffering from complications and comorbidity and in secondary hospitals. Table 2 presents the characteristics after matching. The average age of patients was 62.44±10.61 years in 2014. There were no significant differences in those covariates between the two groups in 2014. Observed covariate balances were satisfied after matching due to standardised differences in the means of less than 0.1. Records in 2013 of both groups were traced back according to outpatient number per patient. Characteristics of patients with DM between the two groups in 2013 are presented in online supplementary appendix 4.

Descriptive analysis of patients' expenses
In 2013, total outpatient expenses for DM in Tianjin were ¥2829.16 million. Drugs accounted for the highest proportion of the costs (¥2592.67 million, 91.64%), followed by examinations (¥119.76 million, 4.23%) and treatment (¥26.17 million, 0.93%). The remaining categories had a total cost of ¥90.56 million (3.20%). In 2014, total outpatient expenses for DM were ¥3288.02 million. Drug expenses accounted for the highest proportion of outpatient expenses (¥3037.64 million, 92.39%), followed

by examinations (¥117.05 million, 3.56%) and treatment (¥29.54 million, 0.90%). The remaining categories totalled ¥103.80 million (3.16%). The trends in mean annual expenses for outpatient records between the two groups from 2010 to 2014 are illustrated in figure 2. The variation in trends in mean annual total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses between the two groups was similar from 2010 to 2013. However, from 2013 to 2014, the mean annual total outpatient expenses increased by ¥1358.66 in the pilot group but decreased by ¥484.37 in the control group. The mean annual drug expenses increased by ¥1361.49 from 2013 to 2014 in the pilot group compared with a decrease of ¥399.61 in the control group. The mean annual examination expenses decreased by ¥16.99 in the pilot group and decreased by ¥52.74 in the control group. The mean annual treatment expenses decreased by ¥3.71 from 2013 to 2014 in the pilot group compared with a decrease of ¥6.38 in the control group. Finally, the mean annual other expenses increased by ¥17.87 in the pilot group but decreased by ¥25.62 in the control group. In general, capitation influenced the trends significantly.

DID analysis
Table 3 presents the results of DID analysis. The increase in total outpatient expenses between the

Table 2 Comparison of characteristics between the two groups in 2014 after PSM

Variables	Pilot group (n=4907)	Control group (n=9814)	P value	Standardised differences*
Sex, n (%)			<0.767	
Male	2650 (54.00)	5322 (54.23)		0.005
Female	2257 (46.00)	4492 (45.77)		0.005
Age (years), mean±SD	62.44±10.69	62.44±10.57	0.983	0.000
Number of comorbidities, n (%)			0.966	
0	1800 (36.68)	3605 (36.73)		0.001
1	1020 (20.79)	2043 (20.82)		0.001
≥2	2087 (42.53)	4166 (42.45)		0.002
Number of complications, n (%)			0.964	
0	1343 (27.37)	2689 (27.40)		0.001
1	1473 (30.02)	2964 (30.20)		0.004
≥2	2091 (42.61)	4161 (42.40)		0.004
Types of medical insurance, n (%)			0.756	
Urban employees	4725 (96.29)	9460 (96.39)		0.005
Urban residents	182 (3.71)	354 (3.61)		0.005
Grade of hospitals, n (%)			0.990	
Primary hospitals	1252 (25.51)	2498 (25.45)		0.001
Secondary hospitals	2678 (54.58)	5368 (54.70)		0.006
Tertiary hospitals	977 (19.91)	1948 (19.85)		0.002

*For continuous variables, the standardised differences is defined as

$$d = \frac{|\bar{X}_{pilot} - \bar{X}_{control}|}{\sqrt{\frac{S^2_{pilot} + S^2_{control}}{2}}}$$

where $\bar{X}_{pilot}$ and $\bar{X}_{control}$ indicate the sample mean of the covariates in pilot and control groups, respectively, while S^2_{pilot} and $S^2_{control}$ denote the sample variance. For categorical variables, the standardised differences is defined as

$$d = \frac{|P_{pilot} - P_{control}|}{\sqrt{\frac{P_{pilot}(1 - P_{pilot}) + P_{contorl}(1 - P_{control})}{2}}}$$

where P_{pilot} and $P_{control}$ denote the prevalence of variables in the two groups.
PSM , propensity score matching .

preimplementation and postimplementation periods was ¥1843.03 greater in the pilot group than in the control group. The DID model demonstrated an increase in total outpatient expenses of ¥1993.76 (95% CI, ¥1643.74 to ¥2343.77) in the pilot group relative to the control group after adjusting for confounding factors including age, sex, number of complications, type of medical insurance and hospital grade. The increase in drug expenses between the preimplementation and postimplementation periods was ¥1761.10 greater in the pilot group than in the control group. The adjusted DID model showed an increase in drug expenses of ¥1904.30 (95% CI, ¥1578.63 to ¥2229.96) in the pilot group relative to the control group. The decrease in examination expenses between

the preimplementation and postimplementation periods was ¥35.75 less in the pilot group than in the control group. The adjusted DID model showed an increase in examination expenses of ¥44.90 (95% CI, ¥19.11 to ¥70.68) in the pilot group relative to the control group. The decrease in treatment expenses between the preimplementation and postimplementation periods was ¥2.67 less in the pilot group than in the control group. The adjusted DID model showed an increase in treatment expenses of ¥3.55 (95% CI, ¥1.01 to ¥6.09) in the pilot group relative to the control group. The increase in other expenses between the preimplementation and postimplementation periods was ¥43.49 greater in the pilot group than in the control group. The adjusted DID model showed an increase in

Table 3 Changes in total outpatient expenses, drug expenses, examination expenses, treatment expenses and other expenses in the pilot group relative to the control group

Variables	Mean annual expenses (RMB, ¥)		DID	β_3/regression-adjusted DID (95% CI)	P value*
	Pilot group (n=9646)	Control group (n=25 883)			
Total outpatient expenses					
2013	8357.31	7575.99	1843.03	1993.76 (1643.74 to 2343.77)	<0.001
2014	9715.97	7091.62			
Drug expenses					
2013	7542.94	6945.78	1761.10	1904.30 (1578.63 to 2229.96)	<0.001
2014	8904.43	6546.17			
Examination expenses					
2013	518.89	318.16	35.75	44.90 (19.11 to 70.68)	<0.001
2014	501.90	265.42			
Treatment expenses					
2013	72.10	71.27	2.67	3.55 (1.01 to 6.09)	0.006
2014	68.39	64.89			
Other expenses					
2013	223.38	240.77	43.49	43.46 (26.81 to 60.11)	<0.001
2014	241.25	215.15			

Adjusted for confounding factors including age, sex, number of complications, types of medical insurance and hospital grade.

*Significant difference in β_3 (regression-adjusted DID) from zero is reflected by the p values.

other expenses of ¥43.46 (95% CI, ¥26.81 to ¥60.11) in the pilot group relative to the control group.

There were significant differences in the regression coefficients for interaction terms in the log-transformed DID models, which indicated significant increases in outpatient expenses between the two groups (table 4). Log-transformed DID estimates were consistent with the main model, suggesting that the analyses were not biased by skewed data.[7]

Another sensitivity analysis examining a control group composed of only patients at secondary hospitals was performed. Online supplementary appendix 5 presents results similar to the main model.

DISCUSSION
Characteristics of medical insurance systems in China
In China, the mode of payment for healthcare providers is mainly fee for service (FFS), but more areas have been piloting and implementing alternative payment methods,[16] such as capitation and case-based payment. Those designing payment systems for healthcare in low- and middle-income countries are increasingly looking to capitation payments to avoid the cost inflation experienced with FFS payments.[17] Previous studies showed that capitation was effective in controlling increasing costs.[18–20] A study in Vietnam showed that capitation resulted in a more than 5% decrease in total recurrent expenditure.[5] Capitation policy has been used in many health systems to control unreasonable increases in medical costs. The

policy can reduce the utilisation of medical resources and increase preventive healthcare, but it can have a negative impact on patients' health outcomes.[21–23] Capitation may result in the provision of a suboptimal quality healthcare.[24 25] There is evidence that the incentive for cost control may lead to a shortage of services or the elimination of high-cost patients.[26]

A medical insurance policy for 'outpatient special diseases' was mainly implemented for patients with DM in Tianjin. FFS is the main method of payment for these patients. The 'outpatient special diseases' policy was aimed at patients in a large population who require long-term treatment via both hospitalisation and outpatient treatment and incur a large amount of medical expenses; 13 diseases and conditions are covered in this policy. Medical services received by patients with DM are restricted by the three major directories of health insurance including the drug catalogue, the directory of diagnostic and therapeutic items, and the medical service facilities in hospitals that accepted the 'outpatient special diseases' policy. Before the co-ordinated payment is included, some of these treatments require patients to pay a certain proportion on their own, which may lead patients to accept those treatments selectively. However, for patients involved in the capitation policy, if medical services are provided actively by the hospital, ST Hospital does not charge additional fees regardless of whether they are in line with the three directories. Furthermore, if the hypoglycaemic drug cost of enrolees exceeds ¥10

Table 4 Results of linear regression models for log-transformed expenses (mean change in Y per unit of X, 95% CI)

Variables	Reference	Outpatient expenses	Drug expenses	Examination expenses	Treatment expenses	Other expenses
Year	2013	−0.19 (−0.23 to −0.14)***	−0.24 (−0.28 to −0.20)***	−0.13 (−0.17 to −0.09)***	−0.12 (−0.15 to −0.08)***	−0.74 (−0.87 to −0.62)***
Pilot	Without capitation	−0.06 (−0.12 to −0.01)*	0.11 (0.06 to 0.16)***	0.48 (0.43 to 0.53)***	–	−0.19 (−0.33 to −0.04)*
Pilot*year	Exception of 'pilot*2014'	0.52 (0.44 to 0.60)***	0.32 (0.25 to 0.39)***	0.17 (0.10 to 0.24)***	0.17 (0.12 to 0.21)***	0.50 (0.28 to 0.71)***
Sex	Male	0.05 (0.02 to 0.09)**	0.05 (0.02 to 0.08)**	0.09 (0.05 to 0.12)***	0.06 (0.03 to 0.09)***	–
Age	–	–	–	–	–	−0.02 (−0.03 to −0.02)***
Types of medical insurance	Urban employees	−0.77 (−0.87 to −0.67)***	−0.76 (−0.85 to −0.67)***	−0.61 (−0.71 to −0.51)***	−0.57 (−0.65 to −0.50)***	−1.17 (−1.44 to −0.90)***
Number of complications	-	–	0.04 (0.03 to 0.05)***	–	−0.02 (−0.03 to −0.01)***	0.11 (0.07 to 0.14)***
Secondary hospital	Primary hospital	0.60 (0.55 to 0.64)***	0.28 (0.24 to 0.32)***	−0.10 (−0.13 to −0.06)***	0.16 (0.12 to 0.19)***	1.25 (1.13 to 1.36)***
Tertiary hospital	Primary hospital	0.35 (0.32 to 0.38)***	0.19 (0.16 to 0.22)***	−0.37 (−0.40 to −0.34)***	0.03 (0.00 to 0.05)*	1.35 (1.27 to 1.44)***

*P<0.05; **P<0.01; ***P<0.001.

000, it can still be reimbursed online. Patients enrolled in the 'outpatient special diseases' policy need to pay for the excess themselves and declare it at the end of the year. Further, patients can choose 'three hospitals, one drugstore' according to their condition. In addition, doctors at ST Hospital pay more attention to health education and promotion, such as guidelines on diet and physical exercise for patients, which in turn decrease unreasonable medical costs by reducing the incidence of complications and comorbidities. However, there were also problems with the policy. For example, there were some inconveniences for enrolees in the treatment of DM-related complications.

Impact of capitation policy on outpatient expenses

In this analysis, capitation was associated with a significant increase in expenses for people with DM, which was inconsistent with certain previous studies in the same field.[5 17] Capitation was found to help medical staff build active cost control consciousness.[16] There are four explanations for this phenomenon. First, the lack of autonomy and independence of public hospitals made them less responsive to economic incentives.[27] Public hospitals are dependent on different government departments for the allocation of human, financial and physical resources in China. ST Hospital is a secondary public hospital. Medical staff and managers lack awareness of and autonomy in cost control at these hospitals, resulting in problems such as lack of effective cost constraint mechanisms, waste of medical resources and excessive consumption. Second, capitation policy refers to the practice, whereby medical insurance agencies (governmental agencies) pay for medical expenses reimbursed by a capitation standard to designated hospitals. Once the costs of patients with DM enrolled in capitation were within the standard range, the social security monitoring system did not continue extensive monitoring. The expenses of hospitals without the policy were irregularly supervised, which may encourage healthcare workers to focus on cost control. Third, in the first year of policy implementation, doctors paid more attention to building trusting relationships with patients with DM, but often neglected cost control. It is important for doctors to gain the trust of these patients because they sign up for long-term, 'one-on-one' guidance. Doctors need to establish long-term treatment programmes for patients' conditions so that patients can obtain more information about their treatment. In this way, 'fixed' individualised diagnosis and treatment can be established that will ultimately benefit the patients' health. Finally, drug expenses and examination expenses were significantly higher in the patients enrolled in capitation than in the 'outpatient special diseases' policy (table 3). Patients participating in capitation were prescribed not only hypoglycaemic drugs but also drugs for lowering blood pressure, lowering blood lipids and managing DM-related complications based on their condition. They were scheduled to undergo a routine blood examination every month and HbA1c level tests every 3 months. Therefore,

their drug expenses and examination expenses were higher. For patients, participating in the policy can help them regularly monitor their condition and make it more convenient for them. In subsequent research, a retrospective cohort study will be carried out to evaluate associations among policy, medical costs and health outcomes (such as HbA1c, number and severity of complications).

Policy suggestions

These results suggest that the supervision of medical services must be strengthened.[28] Management systems should promptly implement dynamic supervision and network notifications for service quality, medical expenses and patient satisfaction. Next, a variety of payment methods should be considered within the capitation system.[16] Although capitation is expected to control unreasonable increases in medical costs, it also has some limitations. Therefore, it is recommended that a variety of payment methods be combined to complement each other. Additionally, the results suggest that a competition mechanism should be established. Doctors with good medical cost control have high performance, but the patients' health indicators should be incorporated into the performance management system. Self-restraint and incentive mechanisms should be established in pilot hospitals.

Limitations

This study has several limitations. First, there is a lack of survey information available on the following topics: health-seeking behaviours, disease control, the severity of patient comorbidities and complications and patient satisfaction with DM treatment. Second, research on the associations among capitation, health outcomes and medical costs is lacking. Third, medicine use per patient in both groups was not specific; for example, we do not know how total costs are driven by drug costs. Furthermore, this analysis only covered the effect of the year after the implementation of the policy. The feasibility and scientific basis of the policy need to be analysed with additional years of data.

CONCLUSION

Compared with those who did not participate in the policy, annual total outpatient expenses, drug expenses and examination expenses per outpatient with DM enrolled in the capitation policy increased significantly. These increases were due to actual patient needs, changes in drug directories, and the autonomy and independence of hospitals. Further study is needed to assess longer-term associations among the policy, health outcomes and medical costs.

REFERENCES

1. International Diabetes Federation. DF Diabetes Atlas -8th edition. http://www.diabetesatlas.org/across-the-globe.html (Accessed 20 Dec 2017).
2. Wang HP, Hou ZY, Meng QY. A comparative study on medical expenditure for diabetes mellitus and non-diabetes mellitus in 9 provinces of China, between 2000 and 2009. *Zhonghua Liu Xing Bing Xue Za Zhi* 2013;34:911–3. in Chinese.
3. Sood N, Alpert A, Barnes K, *et al*. Effects of payment reform in more versus less competitive markets. *J Health Econ* 2017;51:66–83.
4. Liu X, Liu Y, Lv Y, *et al*. Prevalence and temporal pattern of hospital readmissions for patients with type I and type II diabetes. *BMJ Open* 2015;5:e007362.
5. Nguyen HT, Bales S, Wagstaff A, *et al*. Getting Incentives Right? The Impact of Hospital Capitation Payment in Vietnam. *Health Econ* 2017;26:263–72.
6. Elixhauser A, Steiner C, Harris DR, *et al*. Comorbidity measures for use with administrative data. *Med Care* 1998;36:8–27.
7. Blavin F. Association between the 2014 medicaid expansion and US Hospital Finances. *JAMA* 2016;316:1475–83.
8. Stuart EA. Matching methods for causal inference: a review and a look forward. *Stat Sci* 2010;25:1–21.
9. Berian JR, Ban KA, Liu JB, *et al*. Association of an Enhanced Recovery Pilot With Length of Stay in the National Surgical Quality Improvement Program. *JAMA Surg* 2018;153:358–65.
10. Rubin DB. Using propensity scores to help design observational studies: application to the tobacco litigation. *Health Services and Outcomes Research Methodology* 2001;2:169–88.
11. Austin PC. Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. *Stat Med* 2009;28:3083–107.
12. French B, Heagerty PJ. Analysis of longitudinal data to evaluate a policy change. *Stat Med* 2008;27:5005–25.
13. Dimick JB, Ryan AM. Methods for evaluating changes in health care policy: the difference-in-differences approach. *JAMA* 2014;312:2401–2.
14. Angrist JD, Pischke JS. *Mostly Harmless Econometrics: An Empiricist's Companion*. Princeton University Press: Princeton, NJ, 2008.
15. Zhou Z, Su Y, Campbell B, *et al*. The financial impact of the 'zero-markup policy for essential drugs' on patients in county hospitals in western rural China. *PLoS One* 2015;10:e0121630.
16. Jing L, Bai J, Sun X, *et al*. NRCMS capitation reform and effect evaluation in Pudong New Area of Shanghai. *Int J Health Plann Manage* 2016;31:e131–57.
17. Mills A, Bennett S, Siriwanarangsun P, *et al*. The response of providers to capitation payment: a case-study from Thailand. *Health Policy* 2000;51:163–80.
18. Wang X, Zhu S. A comparison of medical payment modes. *Chin J Hosp Adm* 2006;22:57–9. in Chinese.
19. Dong CH, Fan CS. Negotiation mechanisms between medical insurance institutions and medical institutions under quota payment. *China Soc Secur* 2011:76–7. in Chinese.
20. Feng B. *Research on funding of public hospitals*. Wuhan: Huazhong University of Science and Technology, 2012. in Chinese.
21. Balkrishnan R, Hall MA, Mehrabi D, *et al*. Capitation payment, length of visit, and preventive services: evidence from a national sample of outpatient physicians. *Am J Manag Care* 2002;8:332–40.
22. Dhanani N, O'Leary JF, Keeler E, *et al*. The effect of HMOs on the inpatient utilization of medicare beneficiaries. *Health Serv Res* 2004;39:1607–28.

23. Glazier RH, Klein-Geltink J, Kopp A, *et al*. Capitation and enhanced fee-for-service models for primary care reform: a population-based evaluation. *CMAJ* 2009;180:E72–81.
24. Ellis RP. Creaming, skimping and dumping: provider competition on the intensive and extensive margins. *J Health Econ* 1998;17:537–55.
25. Ca M. Health care payment systems: cost and quality incentives. *Journal of Economics & Management Strategy* 1994;3:93–112.
26. Hirunrassamee S, Ratanawijitrasin S. Does your health care depend on how your insurer pays providers? Variation in utilization and outcomes in Thailand. *Int J Health Care Finance Econ* 2009;9:153–68.
27. Pan J, Liu GG, Gao C. How does separating government regulatory and operational control of public hospitals matter to healthcare supply? *China Economic Review* 2013;27:1–14.
28. Cohen SB, Makuc DM, Ezzati-Rice TM. Health insurance coverage during a 24-month period: a comparison of estimates from two national health surveys. *Health Serv Out Res Meth* 2007;7:125–44.