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Impact of the family doctor system on the continuity of care for diabetics in urban China: a difference-in-difference analysis

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ABSTRACT

Objectives Our study aimed to examine whether the family doctor system can improve continuity of care for patients with diabetes.

Design Registry-based, population-level longitudinal cohort study.

Setting Linked data from the administrative Health Information System and the Health Insurance Claim Databases in a sample city in eastern China.

Participants 30 451 insured patients who were diagnosed with diabetes before January 2015 in the sample city, with ≥2 outpatient visits per year during 2014–2017. Diabetics in the intervention group had been registered with family doctor teams from 2015 to 2017, while those who had not registered were taken as the control group.

Interventions The family doctor system was established in China mainly to strengthen primary care and rebuild referral systems. Residents were encouraged to register with family doctors to obtain continuous health management especially for chronic disease management.

Outcome measures Continuity of care was measured by the Continuity of Care Index (COCI), Usual Provider Continuity Score (UPCS) and Sequential Continuity of Care Index (SECON) in 2014–2017.

Results COCI, UPCS and SECON of all diabetics in this study increased between 2014 and 2017. A difference-in-difference approach was applied to measure the net effect of the family doctor system on continuity of care. Our model controlled for demographic and socioeconomic characteristics, and severity of disease at baseline. Compared with the control group, diabetics registered with family doctors obtained an average 0.019 increase in COCI (SE 0.002) ($p<0.01$), a 0.016 increase in UPCS (SE 0.002) ($p<0.01$) and a 0.018 increase in SECON (SE 0.002) ($p<0.01$).

Conclusion This study provides evidence that the family doctor system can effectively improve continuity of care for patients with diabetes, which has substantial policy implications for further primary care reform in China.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ This is the first study in China to measure the effect of the family doctor system on continuity of care, which enriches the evidence on the impacts of the family doctor system in China.
⇒ The difference-in-difference (DID) method was employed to evaluate the net effect of family doctor system by eliminating confounding factors, and DID after propensity score matching was applied to ensure robustness and credibility.
⇒ This study is based on a large-scale, longitudinal claim database, which contained information on medical visits occurring at all levels of health institutions in the sample city, enabling to accurately calculate the continuity of care indicators and track of their changes over time.
⇒ As measured at the institutional level instead of the physician level, continuity of care might be slightly overestimated based on the assumption that a patient would visit the same general physician when visiting the same community health centre.

INTRODUCTION

Similar to many countries in the world, China is facing the challenges of an increasing chronic disease burden.[1] In China, there were 34.3% of the total population suffers from chronic disease,[2] which has become a major public health problem affecting economic and social development. Chronic diseases, characterised by long duration and slow progression, have a considerable impact on residents, families and societies by decreasing quality of life and productivity; further, if they are not effectively managed, they result in acute or long-term complications that can lead to hospitalisations and a heavy financial burden.[3] Providing healthcare services with good continuity for patients with chronic diseases, connecting and coordinating care between patients and providers across time and settings, is key to the effective management of chronic diseases.[4 5]

Continuity of care is one of the core elements of integrated care, which was proposed by the WHO in 2016 as the direction of international health system reform.[6] As defined by the WHO, continuity of care refers to the degree to which a series of discrete healthcare events is experienced by people as coherent

and interconnected over time and consistent with their health needs and preferences.[4] Studies have shown that a higher continuity of outpatient health services helps reduce the financial burden of patients with chronic diseases by controlling medical expenses and reducing the incidence of complications, emergency department visits, hospitalisations and mortality.[7–10]

International experience has illustrated that a well-established family doctor system lays a solid foundation for the effective management of chronic diseases by improving continuity of care, which has been hailed by the WHO as the most economical and most appropriate model of healthcare.[11] A considerable amount of research has been conducted on the impact of the family doctor system in other countries during the past decade. The vital role of family doctors has been confirmed in practice and research in the UK, Australia and Canada—improving chronic disease management, reducing emergency department visits and hospitalisations, promoting quality of care and controlling medical costs.[12–18]

To cope with the challenges of the increasing burden of chronic diseases, China has initiated a new round of healthcare reforms since 2009, including measures to strengthen the capacity, quality and efficiency of primary care as well as rebuild the referral system to encourage residents to register with family doctor teams that will act as gatekeepers of their medical care. In recent years, the Chinese government has issued a series of policy documents to guide and promote the construction and improvement of the family doctor system and referral system. According to the policy, family doctor teams, which typically consist of family doctors, nurses and public health physicians, are responsible for establishing a long-term and stable relationship with their patients, following up on their health status and providing them with safe, convenient, effective, continuous, economical, integrated and personalised healthcare.[19]

Existing studies concerning the effect of the family doctor system in China mainly focus on patient satisfaction,[20–22] patients' utilisation of primary healthcare services,[23 24] patients' medical expenses[20] and so on. However, these studies do not address the effect of the family doctor system on continuity of care, which is particularly important for patients with chronic diseases. Thus, there is a lack of knowledge about whether the implementation of the family doctor system in China has improved continuity of care among patients with diabetes. The aim of our study, therefore, was to investigate the effects of the family doctor system on continuity of care among patients with diabetes in a Chinese urban setting.

METHODS

Settings

Sample City

This study was conducted in a sample city in eastern China (H city), which had a population of approximately 10 million in 2019, with the social medical insurance, including the urban employee basic medical insurance (UEBMI) and the urban–rural resident basic medical insurance (URRBMI), covering more than 95% of the residents.

Healthcare package of family doctor system

In H city, the family doctor system was initiated in 2015, aiming to promote health management for residents, especially for patients with hypertension and diabetes in the pilot phase. All 131 public community health centres (CHCs) in H city with more than 2000 family doctor service teams implemented the family doctor system. To encourage family doctors to provide health management services to registered residents, CNY120 per capita per year were paid jointly by the medical insurance, government subsidies and registered residents. Following health services were provided by family doctors to registered residents: (1) personalised health management services and consultation based on individuals' health files or medical records from municipal hospitals; (2) priority treatment and expedited referrals and (3) health assessment once a year.

Residents' registry and benefits to family doctor system

The family doctor system as a 'gatekeeper' is voluntary rather than compulsory. Residents are encouraged to register with family doctors in nearby CHCs each year and to use primary care and disease management provided by family doctors.

If registered, residents were offered following healthcare benefits. First, the medical insurance deductible and the co-payment ratio of patients could be reduced conditionally for the patients who had enrolled in the family doctor system.[25] This medical insurance policy aims to encourage residents to use primary care or to use secondary/tertiary hospital medical services with referrals from their family doctors. Second, patients can benefit from 'green channel' referrals which means directly referring to certain specialists without long waiting.[26]

One thing needed to be mentioned that, family doctor system in China was considered a kind of healthcare service rather than strict 'gatekeepers'. It did not yet explicitly restrict patients' access to health service providers,[27] which meant that patients were free to decide which healthcare provider to visit when sick under this system.

Population covered by family doctor system

The number of participants in H city had grown from 0.51 million in 2015 to 3.04 million in 2019, covering about 30% of the entire population in the city, of which nearly 70% of the participants were elderly or patients with chronic diseases. According to the government's requirements, key populations of the family doctor system include the elderly, maternity, children, people with disabilities and patients with hypertension, diabetes, tuberculosis and severe mental disorders, etc.[28] As of 2019, the coverage rate of key populations of the family doctor

system in H City reached more than 80%, which was much higher than the 60% required by the government.

Data sources

We used data from two separate databases. First, from the official health management information system, an administrative dataset managed by the Health Commission of H city, we identified all patients diagnosed with diabetes before January 2015 and extracted their social demographics, registration status and detailed information of the health follow-up from 2014 to 2017. By linking with the patients' identification, we extracted the records of patients' healthcare uses and costs from the medical insurance claim database, which is managed by the Healthcare Security Bureau of H city.

Inclusion criteria for enrolment were as follows: (1) patients with social medical insurance, either UEBMI or URRBMI, (2) patients with more than two outpatient visits per year, which was required for the indicator calculation and (3) patients who were registered with family doctors for the entire 3 years from 2015 to 2017, or those who were not enrolled during 2015–2017. Patients who were partially enrolled during the follow-up period were excluded from the study.

Measures of continuity of care

In this study, three indicators of continuity of care were applied, namely, the Continuity of Care Index (COCI), the Usual Provider Continuity Score (UPCS) and the Sequential Continuity of Care Index (SECON), to depict continuity of care from the perspectives of dispersion, density and sequence. It should be noted that, we made some adjustments to the original calculation formulas for these three indicators. First, the healthcare service providers in these indicators were adjusted from individual doctors to primary healthcare institutions. There are several reasons for this. In China, primary care services are organised by CHCs and delivered on an institutional basis, with family doctors as employees of the CHCs. In addition, in terms of data acquisition, the records of patient visits in the claims database only have information on the institutions patients visited instead of the specific doctor for each visit. Therefore, in our study, continuity of care was defined at the institutional level based on the hypothesis that a patient would visit the same primarycare physician when visiting the same CHC (for registered patients, we hypothesised that they would visit their registered family doctor when visiting the CHC they registered with). Second, we limited the scope of medical institutions in the index calculation formula to primary care institutions to focus on the continuity of care provided by the primary healthcare institutions, excluding hospitals at all levels. Therefore, we still consider such services to be discontinuous even if the patient visits the same secondary or tertiary hospital consecutively.[29] The first indicator, COCI, is widely used to measure the distribution of providers selected by patients during a specific period.[9] In this study, we adjusted the calculation formula to reflect the proportion and dispersion of the outpatient services provided by primary healthcare institutions compared with the total number of outpatient visits. In our study, the COCI was expressed as follows:

$$COCI = \frac{\sum_{i=1}^{M} n_i^2 - N}{N \cdot (N-1)},\ N \geq 3$$

where N is the total number of a patient's outpatient visits in a certain year (including outpatient visits at all levels of healthcare institutions), n_i is the number of a patient's visits at the i^{th} CHC and M is the total number of CHCs that the patient visited during the year.

The value range of COCI was −0.5 to 1, with a higher score representing a higher proportion of primary healthcare utilisation and better continuity of care. A score of 1 was obtained if a patient's outpatient visits all occurred at the same CHC; a score of 0 was obtained if a patient's outpatient visits occurred at different CHCs; and the score was negative if a patient's outpatient visits all occurred in a secondary or tertiary hospital.

The second indicator is UPCS, which was used to evaluate the proportion of a patient's visits to a certain provider compared with all of his or her outpatient visits.[30] The UPCS is expressed as follows:

$$UPCS = \frac{n}{N},\ N \geq 3$$

where N represents the total number of a patient's outpatient visits and n denotes the number of outpatient visits to the primary healthcare institution the patient accessed for most visits. The value range of UPCS was 0–1, with a higher score representing a higher concentration and continuity of primary healthcare utilisation. A score of 1 was obtained if a patient's outpatient visits all occurred at the same CHC, and the score was closer to 0 if a patient's outpatient service utilisation was scattered among various CHCs or occurred more often in secondary or tertiary hospitals.

The third indicator is SECON, which was used to assess continuity and focuses on the sequence of visits to different providers.[31] The SECON is expressed as follows:

$$SECON = \frac{\sum_{i=2}^{n} S_i}{n-1},\ n \geq 3$$

where n represents the total number of a patient's outpatient visits, and S_i equals 1 if the i^{th} visit and $i\text{-}1^{th}$ visit were made to the same CHC; otherwise, S_i=0. The range of the SECON value is 0–1. SECON takes the value of 1 if every consecutive visit is made to the same primary care provider and 0 if every visit is made to a different primary care provider.

The three indicators, COCI, UPC and SECON, focus on different dimensions of continuity and characterise continuity of care for patients with diabetes with a combination of density, dispersion and sequence perspectives. The COCI emphasises the dispersion of care providers across all providers seen by patients, and the UPCS focuses more on the density of care by the usual provider,

while the SECON measures the utilisation of healthcare services from a sequential perspective.[32 33]

Covariates

We combined several covariates in our analysis to control the sociodemographic characteristics and health conditions of patients. Variables that reflected patients' sociodemographic characteristics were included, such as age, gender and types of medical insurance (UEBMI or URRBMI). Patients were divided into several age groups: ≤30 years, 31–40 years, 41–50 years, 51–60 years, 61–70 years, 71–80 years, 81–90 years and ≥90 years. In addition, some indicators that represented the subjects' health conditions were included, such as whether they had diabetes and hypertension at the same time, and the body mass index (BMI), including normal (18.5 kg/m^2≤BMI≤ 24.0 kg/m^2), above normal (BMI >24.0 kg/m^2) and below normal (BMI <18.5 kg/m^2). The indicator related to the state of disease control at baseline (in 2014) was also included in the model: the average fasting blood glucose (FBG) score. In this study, the average FBG score was calculated by scoring the patient's FBG at each follow-up, which received 1 point if the value was within the normal range of FBG and 0 otherwise, and the average FBG score was calculated based on FBG scores from all follow-up visits in 2014. The normal range of FBG was set to 4.4–7.0 mmol/L according to the control target of type 2 diabetes in China.[34]

The time dummy variables (with the year 2014 as the reference) were included to control features that could change over time. Because we tried to analyse whether the family doctor system is a possible factor for the improvement in continuity of care, we divided all of the patients who met the inclusion criteria into two groups—the intervention group and the control group. Our intervention group consisted of patients who registered with family doctor teams from 2015 to 2017, while the control group consisted of patients who did not register with any family doctor team from 2015 to 2017.

Statistical analyses

A difference-in-difference (DID) model was employed in this study, estimated with the following equation:

$$Y_{it} = \alpha + \beta_1 \cdot group_i + \beta_2 \cdot t + \beta_3 \cdot group_i \times t + \beta_{4j} \cdot X_{ij} + \varepsilon_{it}$$

where Y_{it} refers to continuity of care indicators (COCI, UPCS or SECON) for the i^{th} patient at year t; $group_i$ equals 1 if the i^{th} patient is divided into the intervention group and 0 for the control group; t indicates the time of the observation (2014 or 2017); group×t refers to the interaction of group and time, with its coefficient β_3 representing the average effect of the family doctor system on the continuity of care indicators; and X_j is a vector of control variables as mentioned above.

The DID approach requires that the outcomes show parallel trends between the intervention group and the treatment group ('parallel trend assumption') in the preintervention periods. However, we only had data for 1 year before the intervention, thus we were unable to conduct the parallel trends test. A robustness test was undertaken to determine whether the results are consistent. Considering the large difference between the number of patients in the intervention group and the control group, a further DID analysis was performed after the patients of the two groups were matched with a 1:1 propensity score matching (PSM) approach based on the patients' gender, age, types of medical insurance, whether diabetes was combined with hypertension, and BMI. All analyses were performed using Stata software, V.15.

Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

RESULTS

Descriptive statistics

Table 1 displays descriptive statistics for gender, age, whether diabetes was combined with hypertension, types of medical insurance, BMI and FBG and its average score in 2014 by group. Our research included 30 451 diabetes patients (mean age 66.56 years, SD 10.45, 13,787 (45%) men and 16 664 (55%) women). Of them, 26 597 patients had registered with family doctor teams for 3 years and were assigned to the intervention group, while 3854 patients who had not registered were enrolled in the control group.

Table 2 presents the average number of outpatient visits, the average number of outpatient visits at CHCs, and the average COCI, UPCS and SECON of each group in 2014 and 2017. In 2014, prior to the initiation of the family doctor system, the distribution of the three continuity of care indicators was substantially different between the intervention group and the control group (histograms of the distribution within each cohort were provided in online supplemental figures 1–12), and average scores for all three indicators were higher in the intervention group than in the control group. Significant changes in all three indicators occurred in both groups after the implementation of the family physician system. The average COCI of diabetes in the intervention group presented an increase of 0.07 in contrast with 0.02 in the control group, while the improvement in UPCS in the intervention group was three times that of the control group (0.06 vs 0.02), and the increase in SECON for the intervention group and the control group was 0.08 and 0.03, respectively.

DID estimates

Table 3 describes the results of the DID analysis of the main model and the DID estimates after PSM (PSM-DID), which determine the effects of the family doctor system on continuity of care among diabetes patients. According to the results of the main analysis model, compared with the control group, patients in the intervention group obtained an average 0.019 increase in COCI (SE 0.002)

Table 1 Descriptive statistics of patients in each group

Descriptive statistics	Total (N=30 451)	Intervention group (N=26 597)	Control group (N=3854)
Gender: Male, n (%)	13 787 (45.28)	11 707 (44.02)	2080 (53.97)
Age, years	66.56 (10.45)	66.96 (10.21)	63.77 (11.58)
Age group, n (%)			
≤30	32 (0.11)	20 (0.08)	12 (0.31)
31–40	230 (0.76)	149 (0.56)	81 (2.10)
41–50	1480 (4.86)	1114 (4.18)	366 (9.50)
51–60	6915 (22.71)	5853 (22.01)	1062 (27.56)
61–70	10 965 (36.01)	9750 (36.66)	1215 (31.53)
71–80	7910 (25.98)	7101 (26.70)	809 (20.99)
81–90	2810 (9.23)	2510 (9.44)	300 (7.78)
>91	109 (0.36)	100 (0.38)	9 (0.23)
Diabetes combined with hypertension, n (%)	24 120 (79.21)	21 727 (81.69)	2393 (62.09)
Types of medical insurance, n (%)			
Employees' insurance	4449 (14.61)	4394 (16.52)	55 (1.43)
Residents' insurance	26 002 (85.39)	22 203 (83.48)	3799 (98.57)
BMI*			
Normal, n (%)	14 460 (47.49)	12 447 (46.80)	2013 (52.23)
Above normal, n (%)	15 114 (49.63)	13 383 (50.32)	1731 (44.91)
Below normal, n (%)	803 (2.64)	700 (2.63)	103 (2.67)
NA, n (%)	74 (0.24)	67 (0.25)	7 (0.18)
Fasting blood glucose, mmol/L	6.19 (0.76)	6.21 (0.76)	6.10 (0.74)
Average fasting blood glucose score, point	0.89 (0.22)	0.88 (0.22)	0.90 (0.21)

The mean (SD) was calculated for continuous variables. N (%) was for categorical variables.
*There were missing values. For the total research subjects, there were 67 missing values for BMI in the intervention group and 7 in the control group.
BMI, body mass index.

(p<0.01), a 0.016 increase in UPCS (SE 0.002) (p<0.01) and a 0.018 increase in SECON (SE 0.002) (p<0.01). All of the results were statistically significant (online supplemental table 1 for the completed results of regression analysis).

Robustness test

According to the results of the robustness test, the DID estimates after PSM matching were larger than those of the main model. This result was consistent with the results of the main analysis (online supplemental tables 2–4). However, most of the patients in the intervention group were not matched and were not included in the PSM-DID analysis model due to the 1:1 matching, resulting in a great loss of the study population and the possibility of obtaining biased estimates. Thus, the estimates of the PSM-DID model were only regarded as the robustness test for the results of the main model analysis, and the interpretation and discussion of the results were carried out with the results of the main model.

DISCUSSION

There is a paucity of studies that focus on the dimension of continuity of care, although many studies have been carried out to evaluate the impact of the family doctor system in China in the past decade. In this study, continuity of care was measured by three indicators—COCI, UPCS and SECON—which depicted the characteristics of continuity of care from density, dispersion and sequence, respectively. Our study examined the effect of the Chinese family doctor system on continuity of care for patients with diabetes using a longitudinal claims database in eastern urban China. Our findings indicated that the family doctor system could improve continuity of care for patients with diabetes from the perspectives of COCI, UPCS and SECON. The rise in COCI indicated an increase in the density of patients' outpatient visits and also an increase in the level of patients' visits to primary healthcare institutions. The increase in UPCS indicated a greater focus on patients' outpatient visits to their regular primary care facilities. The rise in SECON illustrated that patients were more likely to continuously

Table 2 Average number of outpatient visits and score of continuity of care indicators in 2014 and 2017

Group	Indicators	2014	2017	Difference	P value
Intervention group	No of outpatient visits	34.11 (23.42)	36.26 (25.45)	2.15	<0.001
	No of outpatient visits at CHCs	25.14 (18.12)	28.70 (20.64)	3.57	<0.001
	COCI	0.43 (0.33)	0.50 (0.31)	0.07	<0.001
	UPCS	0.59 (0.28)	0.65 (0.25)	0.06	<0.001
	SECON	0.52 (0.31)	0.60 (0.29)	0.08	<0.001
Control group	No of outpatient visits	27.12 (20.46)	27.48 (21.14)	0.36	0.446
	No of outpatient visits at CHCs	12.93 (15.30)	13.86 (16.58)	0.93	0.011
	COCI	0.18 (0.29)	0.20 (0.30)	0.02	0.036
	UPCS	0.33 (0.30)	0.35 (0.31)	0.02	0.028
	SECON	0.27 (0.30)	0.30 (0.31)	0.03	0.001
P value (comparison between groups)	No of outpatient visits	<0.001	<0.001	–	–
	No of outpatient visits at CHCs	<0.001	<0.001	–	–
	COCI	<0.001	<0.001	–	–
	UPCS	<0.001	<0.001	–	–
	SECON	<0.001	<0.001	–	–

The mean (SD) was shown in this table.
CHCs, community health centres; COCI, Continuity of Care Index; SECON, Sequential Continuity of Care Index; UPCS, Usual Provider Care Score.

visit the same primary care institution from the perspective of sequence.

The continuity of care for patients with diabetes in our study was consistent with those from international studies.[25 35 36] However, because our family doctor system is different from most countries in the world, the results of our study cannot be compared with those from international studies. In our study, the family doctor system in the sample city generally resembles the family doctor-oriented primary care models in other countries or regions: patient-centred medical homes in the USA,[37] disease management programmes in Germany,[17] family health teams in Canada,[18] care group-based chronic disease management in the Netherlands,[38] and the management model of chronic diseases with the Quality and Outcomes Framework in the UK.[39] However, the family doctor system in China does not share a key characteristic that is often found in these other models—the financial incentive mechanisms such as pay-for-performance, capitation or bundled payment.

This study showed that patients who were female, older, combined with hypertension, had a BMI above the normal range, were covered by URRBMI and had a lower FBG score, were more inclined to register with family doctors. This finding was consistent with the research conclusions of Huang *et al*,[40] Liu *et al*[41] and Li *et al*.[42] Patients with chronic diseases, who are potentially more vulnerable, will frequently experience difficulties with disease treatment, disease control, adjusting treatment regimens, etc. They are more in need of targeted health guidance and personalised chronic disease management services from family doctors, and as a result, they are more inclined

Table 3 Impact of the family doctor system on continuity of care for diabetes

	COCI		UPCS		SECON	
Dependent variables	Main model	PSM-DID	Main model	PSM-DID	Main model	PSM-DID
DID estimates	0.019***	0.024***	0.016***	0.020***	0.018***	0.019***
(SE)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Observations (person-years)	60674	15244	60674	15244	60674	15244
R^2	0.134	0.151	0.155	0.182	0.148	0.148

The control covariates included: a group dummy, gender, age group dummies, types of medical insurance dummies, whether combined with hypertension, BMI dummies and the average FBG score in 2014. In these regression models, we included the year dummy to control for fixed effects of the calendar years, and we used the robust SE clustered on the institution-individual level.
Significance level***p<0.01.
BMI, body mass index; COCI, Continuity of Care Index; PSM-DID, propensity score matching-difference-in-difference ; SECON, Sequential Continuity of Care Index; UPCS, Usual Provider Care Score .

to enrol in the family doctor system.[43] In addition, after participating in the family doctor system, patients can benefit from higher health insurance reimbursement rates and green channels for referrals, allowing their varied medical demands to be satisfied.[44] Our study also revealed that patients' sociodemographic characteristics had effects on patients' scores for continuity of care. The regression results showed that the scores for continuity of care were higher for patients who were male, aged 41–70 years, combined with hypertension, had a BMI above the normal range, were covered by URRBMI and had a lower FBG score in 2014. This was consistent with the findings of other research,[9 30 45] reflecting patients with these sociodemographic characteristics may have a higher demand for more convenient, affordable and accessible care. As a result, their compliance and adherence to family doctors was greater, resulting in higher scores for continuity of care.

The effect of the family doctor system on continuity of care can be explained by the following two mechanisms. First, the family doctor system helps establish a stable and close doctor–patient relationship. Studies have shown that continuity of care in community health services is affected by a variety of factors, of which the close connection between doctors and patients is a crucial aspect.[45–47] Moreover, studies have also shown that residents are more willing to visit doctors they trust based on their previous experiences.[47] The family doctor system implemented in China has established mutual trust and a strong relationship between family doctors and registered residents.[48] Therefore, when the registered residents have any health problems, they are more likely to consult their family doctors, and continuity of care will be improved during the process. Second, the family doctor system reinforces the sense of responsibility of family doctors under the competition mechanism. According to the policy, patients can annually choose to continue to contract with the same family doctor, register with another primary physician or even withdraw. Moreover, the income of family doctors is directly linked to the number of contracted patients. Thus, reputation and quality of care are key to retaining patients and earning a higher income. This mechanism can motivate family doctors to provide higher quality healthcare services and more appropriate diagnoses and treatments through more careful consultations and more frequent interactions that enable them to comprehensively understand the patient's disease-related issues. The improvement in quality of care will also, in turn, encourage patients to make more use of healthcare services provided by their family doctors, thereby promoting continuity of care.

The results of this study have significant importance for China's ongoing health system reform. The family doctor system is one of the most important aspects of China's new health system reform, which is of great significance for promoting hierarchical medical systems,[49] and the continuity of care is a key intermediate variable for the family doctor system to play its role. If the family doctor system can ensure continuity of care, it will help promote and improve policies to enhance the health management of patients with chronic diseases and reduce the burden of disease for both society and families. The results of this study confirmed that the family doctor system in China has promoted continuity of care for diabetes, which is of great significance in evaluating whether the implementation of the system meets expectations.

Our study has the following strengths. First, to our knowledge, this is the first study in China to explore the effect of the family doctor system on continuity of care, which enriches the evidence on the impacts of the family doctor system in China and provides foundations for further promoting, developing and improving the reform of the family doctor system. Second, we used large-scale, longitudinal data to conduct this observational study and employed DID analysis to evaluate the net effect of the family doctor system on continuity of care by eliminating related confounding factors, which makes the results of our study more robust and credible than previous studies. Third, considering that the UEBMI and URRBMI schemes were highly developed and covered the majority of the total population in the sample city, by linking the administrative Health Information System and the Health Insurance Claim Databases, we were able to accurately calculate the scores of those continuity of care indicators with information on medical visits occurring in all levels of health institutions, and analyse the impact of the family doctor system. Despite these strengths, this study still had some limitations. First, in this research, we calculated continuity of care at an institutional level, and we assumed that patients receive continuous and collaborative medical services when they visit the same primary care institution. However, we have to admit that the continuity of care for patients in our study might be slightly overestimated. Second, the extrapolation of the findings of our study might be limited. To be more specific, the sample city is a relatively developed city with abundant health resources, and the level of continuity of care for diabetics might be higher than the average level elsewhere in China, which may affect the representativeness to some extent. In addition, we only took patients with diabetes as the study sample, and the effect of the family doctor system on continuity of care may be different among patients with other types of chronic diseases, such as hypertension, chronic obstructive pulmonary disease, cancer, etc, which can be further explored by the future research.

CONCLUSION

The family doctor system in China improved the continuity of care for patients with diabetes, which enriched the evidence of the effectiveness of the family doctor system in China. Our findings suggested that efforts to further roll out and deeply implement the family doctor system nationwide should be strengthened to improve continuity of care and chronic disease management.

Furthermore, continuity of care should be taken as an indicator for family doctor performance evaluation so as to motivate family doctors to better play their role as gatekeepers, especially for patients with chronic diseases.

Contributors WC was the guarantor of this study. WC and LZ coordinated the study throughout, developed the research question, collected data and oversaw study implementation. XL was responsible for the modelling, data cleaning, data analysis, result interpretation and drafting the manuscript. LZ verified the methodology and ensured the validation of the results. WC and LZ reviewed and edited the manuscript. XL and LZ contributed equally to this manuscript. All authors read and approved the final manuscript.

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Data availability statement Data are available on reasonable request. Data are available on reasonable request from WC emailed to wenchen@fudan.edu.cn. The data are daily reimbursement records for outpatient healthcare services from claim database, including date, amount, location and name of the healthcare facility on each transaction in our sample city in China during 1 January 2014 to 31 December 2017.

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