

Direct medical cost of diabetes in rural China using electronic insurance claims data and diabetes management data

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ABSTRACT

Aims/Introduction: To evaluate the annual direct medical cost attributable to type 2 diabetes mellitus according to socioeconomic factors, medical conditions and complications categories.

Materials and Methods: We created uniquely detailed data from merging datasets of the local diabetes management system and the social security system in Tongxiang, China. We calculated the type 2 diabetes mellitus-related total cost and out-of-pocket cost for inpatient admissions and outpatient visits, and compared the cost for patients with or without complications by different healthcare items.

Results: A total of 16,675 patients were eligible for analysis. The type 2 diabetes mellitus-related cost accounted for 40.6% of the overall cost. The cost per patient was estimated to be a median of 1,067 Chinese Yuan, 7,114 Chinese Yuan and 969 Chinese Yuan for inpatient and outpatient cost, respectively. The median total cost for hospital-based care was 3.69-fold higher than that for primary care. The median cost of patients with complications was 3.46-fold higher than that of those without complications. The median cost for a patient with only macrovascular, only microvascular or both macrovascular and microvascular complications were 3.13-, 3.79- and 10.95-fold higher than that of patients without complications. Pharmaceutical expenditure accounted for 51.8 and 79.7% of the total cost for patients with or without complications, respectively.

Conclusions: Although the type 2 diabetes mellitus-related cost per patient was relatively low, it accounted for a great proportion of the overall cost. Complications obviously aggravated the economic burden of type 2 diabetes mellitus. Proper management and the prevention of diabetes and its complications are urgently required to curtail the economic burden.

INTRODUCTION

Diabetes has become a critical public health issue in the 21st century¹. A recent study estimated that among adults in China, the overall prevalence of diabetes was 10.9%². Evidence from previous studies suggests that diabetes imposes a substantial economic burden on affected individuals, their families and communities, as well as on healthcare systems due to its growing prevalence and chronic nature^{3–6}. Furthermore, recent studies have consistently shown that patients with diabetes have an

increased risk of complications^{7,8} that result in hospitalization, disability and premature death^{9,10}.

According to the International Diabetes Federation Diabetes Atlas, global diabetes-related health expenditures were estimated to be at least \$673 billion in 2015¹¹. In China, the direct medical costs (DMC) of type 2 diabetes mellitus was estimated to be \$2.27 billion in 2002 and \$8.65 billion in 2008¹². Unfortunately, the research on diabetes-related health expenditures in China remains limited.

The present study set out to estimate the DMC of type 2 diabetes mellitus among patients receiving antidiabetes

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treatment. We linked databases of diabetes management and health insurance in order to obtain a relatively large sample and a reliable estimation.

METHODS

Study area

The present cross-sectional study was carried out in Tongxiang, close to Shanghai and Hangzhou. The registered population was approximately 689,000, and the per capita disposable income was 44,725 and 27,357 Chinese Yuan (CNY; \$1 \approx 6.5 CNY, £1 \approx 9.5 CNY, €1 \approx 7.0 CNY in 2015) for urban and rural residents in 2015, respectively¹³.

Data source

Data were acquired from two main sources: Tongxiang's diabetes management system and social security system. The diabetes management system was established for healthcare purposes. A community health center provides healthcare to patients diagnosed with type 2 diabetes mellitus who are permanent residents and willing to receive diabetes management. The diabetes management system documents patients' diabetes type, date of diagnosis and demographic information (e.g., sex, date of birth), as well as a unique identification number. The social security system covers approximately 95% of registered residents, and is maintained by the local Social Security Bureau. There were two basic medical insurance plans in 2015: Urban Resident Basic Medical Insurance (URBMI) and Urban Employee Basic Medical Insurance (UEBMI). The insurance claims data contain the total expenditures and out-of-pocket (OOP) expenditures associated with each inpatient visit, outpatient visit and purchase of medication. The medical claims also record insurance type, diagnosed diseases, treatment dates, the names of relevant hospitals and pharmacies, as well as medications, medical materials and laboratory tests.

The present study included individuals who met the World Health Organization criteria for type 2 diabetes mellitus¹⁴ and were registered in the Tongxiang diabetes management system. Meanwhile, the participants had an insurance claim for diabetes and its complications as the primary diagnosis for each visit in 2015. We excluded individuals aged <35 years to avoid the possibility of including patients with type 1 diabetes. Patients with their insurance type changing in 2015 were also excluded. We constructed a distinctively detailed individual-level panel data sample by linking each of the individual datasets using the unique patient identification number in the system.

Definition of complications

Complications were classified into four categories: macrovascular complications (cardiovascular, cerebrovascular artery obstructive disease and foot ulcers), microvascular complications (various levels of nephropathy, retinopathy and peripheral neuropathy), macro- and microvascular complications, and others (diabetic ketoacidosis, hyperglycemic hyperosmolar status, lactic acidosis and hypoglycemia coma and unspecified complications). If a

patient had at least one claim for a complication described above in 2015, he/she was grouped in the category 'patients with complications.' Otherwise, the patient was grouped in the 'no complications' category.

Definition of cost

Direct medical costs included the cost of diagnosis, treatment, laboratory testing, drugs (prescription or nonprescription), medical supplies, care provided by hospital and clinic, and so on. The overall DMC was the healthcare expenditures of type 2 diabetes mellitus patients for hospitalization, outpatient visits and self-medication, no matter what the primary diagnosis was for that particular visit or expenditure. The 'total cost' was defined as the DMC attributable to diabetes and its complications. The 'OOP cost' is the part of the DMC paid by patients themselves. 'Inpatient and outpatient cost' encompass the DMC of hospital stays and outpatient visits. The 'self-medication cost' is defined as non-prescription drug purchases made by the patient, such as at pharmacies outside of hospitals or clinics.

Statistical analysis

We reported percentages for categorical variables, and compared them with Pearson's χ^2 -test. Ordinal variables were analyzed using the Cochran–Armitage test. We evaluated the average unit total and OOP cost according to inpatient admissions, outpatient visits and healthcare provider level. In addition, we compared costs by socioeconomic factors and medical conditions stratified by insurance type. Finally, we described the costs for patients with or without complications by different healthcare items. Because the resulting distribution of cost was skewed, the median and quartile are presented along with the mean and standard deviation. The Wilcoxon rank-sum test was used to compare the pattern of cost between two groups, whereas the Kruskal–Wallis test was used to compare three or more groups.

All statistical analyses were carried out using SAS analytical software (version 9.2; SAS institute Inc., Cary, North Carolina, USA). Statistical significance was established at a two-tailed *P*-value <0.05. This study was approved by the ethics committee of the Zhejiang provincial center for disease control and prevention.

RESULTS

General characteristics of the study population

A total of 16,675 patients had an insurance claim due to type 2 diabetes mellitus and related complications in 2015 and were eligible for analysis. The mean \pm standard deviation age was 63.33 \pm 11.26 years among the 7,136 male patients studied, and 62.84 \pm 11.14 years among the 9,539 female patients studied (*P* = 0.005). As shown in Table 1, 20.97% patients had UEBMI and 79.03% patients had URBMI. Compared with the study's female patients, a significantly greater proportion of male patients had UEBMI (*P* < 0.001) and, on average, had attained a higher level of education (*P* < 0.001). In addition,

Table 1 | Characteristics of study population, by sex

Variable	All	Male	Female	<i>P</i> -value
<i>n</i>	16,675	7,136	9,539	
Age (years)				
<50	11.77	11.45	12.01	0.014
50–70	59.85	59.15	60.37	
≥70	28.38	29.40	27.61	
Insurance type				
UEBMI	20.97	30.55	13.81	<0.001
URBMI	79.03	69.45	86.19	
Education level				
No formal school	35.83	21.05	46.88	<0.001
Primary school	38.62	42.29	35.87	
Middle school or higher	19.79	30.45	11.81	
Unspecified	5.77	6.21	5.44	
Income (CNY per month)				
<1,500	4.10	4.11	4.09	0.387
1,500–2,999	55.56	55.33	55.73	
≥3,000	30.08	29.83	30.27	
Unspecified	10.27	10.73	9.92	
Occupation				
Worker	15.50	19.46	12.54	<0.001
Farmer	53.94	46.69	59.36	
Retired/housework	14.52	12.43	16.09	
Others	16.04	21.41	12.01	
Type 2 diabetes mellitus duration (years)				
<5	52.09	55.55	49.50	<0.001
5–9	37.37	35.15	39.03	
≥10	10.54	9.30	11.47	
Complications	13.97	14.98	13.21	0.006
Macrovascular	11.55	12.53	10.82	
Microvascular	1.38	1.30	1.44	
Macro- and microvascular	0.23	0.28	0.19	
Others	0.81	0.87	0.77	

Data presented as percentages. CNY, Chinese Yuan; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance.

the proportion of farmers for the occupation among women was obviously higher than men (59.36 vs 46.69%). The registered prevalence of complications in the study population was 13.97% (95% confidence interval 13.41–14.55%). Macrovascular complications had the highest prevalence of 11.55%. Male patients had a significantly higher rate of complications than their female counterparts (14.98% vs 13.21%, $\chi^2 = 10.66$, $P = 0.001$).

DMC of diabetes for patients receiving treatment

The overall DMC in 2015 was 120.1 million CNY. The expenditure attributed to diabetes and its complications was 48.8 million CNY – that is, 40.6% of the overall DMC. Of the type 2 diabetes mellitus-related DMC, 19.6 million CNY (40.2%) was paid out of pocket. Among the type 2 diabetes mellitus-related DMC, 27.1 million CNY (55.5%) was spent for outpatient visits and 21.7 million CNY (44.5%) for inpatient visits.

As shown in Table 2, the median type 2 diabetes mellitus-related annual DMC per patient was 1,067 CNY (with a mean of 2,926). The median inpatient cost was 7,114 CNY (with a mean of 14,034) compared with the median outpatient cost of 969 CNY (with a mean of 1,634). The total expenditures for patients with different insurance coverage were not statistically significantly different ($P = 0.463$). However, compared with those enrolled in URBMI, the total cost of inpatient admissions for those enrolled in UEBMI was significantly higher ($P = 0.017$), whereas that for outpatient visits was lower ($P < 0.001$). Patients with URBMI also had a significantly higher OOP cost than those with UEBMI for both outpatient and inpatient visits ($P < 0.001$). For patients with UEBMI, the OOP cost accounted for 22.74 and 30.94% of total costs for inpatient and outpatient visits, respectively. In contrast, for patients with URBMI, the OOP cost accounted for a greater proportion of the total cost: 42.38% of total inpatient expenditures and 48.52% of total outpatient expenditures were paid OOP.

Although the number of patient visits to primary care providers (such as community health centers) was significantly higher than that to hospitals (60.66 vs 38.49%), the total cost incurred at hospitals accounted for 78.06% of type 2 diabetes mellitus-related DMC, compared with 21.51% in primary care. Both total and OOP costs per patient were significantly different among the various levels of healthcare providers (Kruskal–Wallis test, total cost: $\chi^2 = 3291.511$; OOP cost: $\chi^2 = 3797.082$, $P < 0.001$). The median per patient total and OOP expenditure for secondary and tertiary care (e.g., hospital outpatient departments) was 3.69- and 4.26-fold higher, respectively, than the median per visit expenditures at primary care providers. Furthermore, the proportion of OOP cost at hospitals was higher than at primary care providers (41.58 vs 35.09%, respectively). The years of type 2 diabetes mellitus duration was positively associated with the increasing expenditure. The median cost for patients with type 2 diabetes mellitus duration of 5–9 and ≥10 years was 1.48- and 2.59-fold higher, respectively, compared with patients with type 2 diabetes mellitus duration <5 years (Table 2).

Table 3 shows that men had a significantly higher median cost than women for both URBMI and UEBMI (1,131 CNY vs 1,026 CNY for URBMI, and 1,183 CNY vs 866 CNY for UEBMI). Patients with higher education level were more likely to have a higher median cost in URBMI. Furthermore, patients who were farmers had the lowest median cost for URBMI (1,004 CNY), whereas workers with other occupations had the lowest median cost for UEBMI (945 CNY). No statistical significant difference was found for age and income.

DMC among patients with or without complications

Table 4 compares the type 2 diabetes mellitus-related DMC overall and for specific categories of expenditures, among patients with or without complications. The DMC of patients with complications was 3.46-fold higher than that of those

Table 2 | Direct medical costs attributed to diabetes and related complications for diabetic patients with treatment

Variable	Total cost			OOP cost			Proportion of OOP (%)
	Median (P25–P75)	Mean (SD)	Z/ χ^2 , P-value	Median (P25–P75)	Mean (SD)	Z/ χ^2 , P-value	
Overall							
UEBMI (n = 3,497)	1,073 (299–3,121)	4,105 (18,185)	–0.734, 0.463	107 (0–894)	1,056 (4,097)	–30.909	25.71
URBMI (n = 13,178)	1,066 (417–2,605)	2,613 (7,320)		471 (214–1,133)	1,209 (3,223)	<0.001	46.28
Total (n = 16,675)	1,067 (394–2,695)	2,926 (10,585)		432 (143–1,096)	1,177 (3,425)		40.23
Inpatient visits							
UEBMI (n = 472)	7,261 (5,154–15,562)	19,384 (45,894)	2.388, 0.017	1,765 (973–3,372)	4,408 (9,923)	–10.915	22.74
URBMI (n = 1,076)	6,967 (4,953–11,002)	11,687 (21,426)		2,922 (2,088–4,709)	4,953 (9,040)	<0.001	42.38
Total (n = 1,548)	7,114 (4,992–11,886)	14,034 (31,191)		2,636 (1,663–4,420)	4,787 (9,318)		34.11
Outpatient visits							
UEBMI (n = 3,415)	865 (262–2,001)	1,524 (1,831)	–6.248, <0.001	63 (0–588)	472 (888)	–38.944	30.94
URBMI (n = 13,146)	994 (400–2,164)	1,663 (1,995)		451 (206–980)	807 (1,081)	<0.001	48.52
Total (n = 16,561)	969 (372–2,155)	1,634 (1,963)		398 (130–902)	738 (1,053)		45.14
Health-care provider level							
Primary (n = 13,423)	484 (157–1,056)	782 (972)	3,291.511,	197 (45–402)	274 (308)	3,797.082,	35.09
Above primary (n = 8,516)	1,787 (415–4,651)	4,473 (14,459)	<0.001	840 (193–2,060)	1,860 (4,570)	<0.001	41.58
Others (n = 188)	90 (21–263)	1,132 (7,668)		28 (4.5–123)	123 (589)		52.02
Type 2 diabetes mellitus duration (years)							
<5 (n = 8,686)	843 (326–2,092)	2,370 (8,705)	590.998, <0.001	363 (109–876)	995 (3,414)	426.216,	41.97
5–9 (n = 6,231)	1,250 (462–2,912)	2,998 (8,082)		484 (183–1,159)	1,229 (3,129)	<0.001	40.99
≥10 (n = 1,758)	2,187 (821–5,017)	5,417 (21,199)		789 (317–2,056)	1,894 (4,277)		34.96
Complications							
Macrovascular (n = 1,926)	2,946 (900–8,793)	9,490 (28,327)	1274.906, <0.001	1,166 (394–3,580)	3,473 (8,558)	1200.123,	36.60
Microvascular (n = 230)	3,571 (1,537–8,437)	6,858 (8,825)		1,687 (616–3,753)	3,228 (4,230)	<0.001	47.07
Macro- and microvascular (n = 38)	10,319 (4,290–15,815)	14,075 (14,968)		3,517 (1,000–5,934)	5,470 (6,818)		38.87
Others (n = 135)	6,547 (2,120–12,568)	10,815 (21,207)		2,387 (813–5,490)	4,434 (8,382)		40.99
None (n = 14,346)	942 (353–2,211)	1,878 (2,914)		384 (123–884)	794 (1,293)		42.27

Costs are in Chinese Yuan. Primary care providers include community health centers or health stations; providers above the primary level include regional hospitals or tertiary hospitals; other providers include private hospitals/clinics or pharmacies. DMC, direct medical cost; OOP, out of pocket; P25, 25th percentile; P75, 75th percentile; SD, standard deviation; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance.

without complications (3,257 CNY vs 942 CNY at the median, Wilcoxon rank-sum test, $Z = 35.096$, $P < 0.001$). The median expenditures in each category for patients with complications were significantly higher than for those without. Notably, with or without complications, pharmaceutical expenditures accounted for the largest share of total cost (79.68 and 51.77%, respectively). In patients without complications, 42.27% of total costs were paid out of pocket, compared with 37.70% among those with complications. The median DMC for a patient with only macrovascular, only microvascular or both macrovascular and microvascular complications were 3.13-, 3.79-fold and 10.95-fold higher than that of patients without complications (Table 2).

DISCUSSION

The present study evaluated the annual DMC attributable to type 2 diabetes mellitus and its complications according to

socioeconomic factors, medical conditions and complications category. The findings provided reliable and valuable evidence for policymakers and managers regarding efficient use of limited healthcare resources for an aging population.

The present study found the median of annual type 2 diabetes mellitus-related DMC per patient was 1,067 CNY (with a mean of 2,926 CNY). Previous studies showed that expenditures attributable to diabetes vary drastically by region and national income^{1, 15}. In the present study, the average annual DMC was far less than that reported in developed countries, such as the USA (approximately 51,350 CNY for medical expenditures attributed to diabetes per patient)¹⁶, Germany (mean direct cost, approximately 23,464 CNY)¹⁷, Singapore (mean DMC, 13,221 CNY)¹⁸ and Korea (mean DMC, 12,604 CNY)¹⁹, but as much as or more than those in developing countries, such as India (direct medical cost per patient, 1,660 CNY)²⁰, Sudan (mean direct cost of diabetes control, 1,138

Table 3 | Direct medical costs of diabetes according to socioeconomic factors, by insurance type

Variable	URBMI			UEBMI		
	Median (P25–P75)	Mean (SD)	Z/ χ^2 , P-value	Median (P25–P75)	Mean (SD)	Z/ χ^2 , P-value
Sex						
Male	1,131 (446–2,695)	2,946 (10,241)	3.456, 0.001	1,183 (343–3,324)	4,713 (22,146)	-3.954, <0.001
Female	1,026 (402–2,550)	2,413 (4,750)		866 (252–2,935)	3,099 (8,051)	
Age (years)						
<50	1,104 (457–2,765)	2,606 (4,882)	3.339, 0.188	1,041 (261–3,052)	2,462 (3,651)	0.642, 0.726
50–70	1,070 (414–2,590)	2,619 (7,978)		1,076 (311–3,106)	3,897 (15,202)	
≥70	1,044 (410–2,575)	2,603 (6,667)		1,073 (296–3,207)	4,976 (24,490)	
Education level						
No formal school	995 (388–2,511)	2,550 (5,167)	14.443, 0.002	1,214 (320–3,524)	4,567 (14,462)	7.080, 0.069
Primary school	1,119 (444–2,603)	2,692 (9,694)		1,027 (294–2,777)	3,499 (13,163)	
Middle school or higher	1,156 (452–2,926)	2,522 (4,670)		1,087 (303–3,340)	4,625 (22,491)	
Unspecified	1,047 (408–2,698)	2,734 (6,758)		771 (261–2,924)	2,572 (7,706)	
Income						
<1,500	1,080 (429–2,736)	3,298 (8,235)	1.369, 0.713	797 (216–2,596)	2,135 (3,200)	5.218, 0.157
1,500–2,999	1,054 (415–2,600)	2,504 (5,007)		1,030 (303–2,893)	3,497 (10,552)	
≥3,000	1,091 (422–2,577)	2,707 (10,447)		1,039 (284–3,395)	4,946 (26,424)	
Unspecified	1,061 (406–2,645)	2,645 (6,733)		1,293 (342–3,356)	4,801 (17,963)	
Occupation						
Worker	1,123 (448–2,660)	2,426 (4,827)	46.937, <0.001	945 (294–2,411)	3,075 (16,970)	18.469, <0.001
Farmer	1,004 (393–2,460)	2,571 (7,906)		1,033 (289–2,742)	3,040 (7,073)	
Retired/housework	1,335 (516–3,088)	2,885 (4,490)		1,312 (304–3,921)	5,666 (24,392)	
Others	1,202 (462–2,785)	2,798 (7,730)		1,071 (310–2,949)	3,481 (11,019)	
Proportion of OOP (%)	46.28%				25.71%	

Costs are in Chinese Yuan. DMC, direct medical cost; OOP, out of pocket; P25, 25th percentile; P75, 75th percentile; SD, standard deviation; UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance.

CNY)²¹ and Brazil (median direct cost of diabetes, 1,281 CNY)²². However, the average DMC in the present study is somewhat less than previous studies carried out in China. For example, a cross-sectional survey in rural Yunnan Province reported that the median DMC was approximately 3,890 CNY and the mean 5,611 CNY²³. In addition, a cross-sectional study carried out in four major cities of China estimated that median DMC was 4,800 CNY and mean DMC was 10,164 CNY²⁴. However, we found that in Tongxiang, both inpatient and outpatient expenditures were higher than those reported in Yunnan (7,114 CNY vs 3,871 CNY for median inpatient costs; 969 CNY vs 271 CNY for median outpatient costs)²³. Meanwhile, the Tongxiang inpatient costs were less than the inpatient costs reported in four major cities of China (7,114 CNY vs 9,897 CNY median spending), whereas the outpatient costs were higher (969 CNY vs 244 CNY)²⁴. This pattern of differences is consistent with the relative differences in per capita living standards of the three sampled populations, because Tongxiang's economy is better than Yunnan's, but not as good as the major cities of China.

Although comparisons of resource use across countries or regions are difficult because of differences among healthcare systems, cost definitions and methodologies, it is logical that the estimated DMC is slightly smaller in the present study.

First, most previous studies were based on self-reported questionnaires, which might produce recall bias. This electronic system-based study made it possible to estimate the costs more precisely. Second, our population-based study features a relatively large sample size with a smaller proportion of hospital admissions. By contrast, the previous, hospital-based study includes a greater proportion of severely ill patients. Third, primary care providers encompass several services funded by per capita public health spending for managing patients, including normally four free blood glucose tests and one free physical examination every year. Furthermore, the majority of patients in Tongxiang are farmers, and most of these patients received diabetes treatment and related health services at community clinics that cost less than similar services provided at urban hospitals.

Among the type 2 diabetes mellitus-related DMC, 55.5% was incurred during outpatient visits and 44.5% incurred during inpatient admissions. Regarding the specific components of expenditure, pharmaceuticals accounted for 79.68% of the DMCs for patients without complications and 51.77% for those with complications. In contrast, the Costs of Diabetes in Europe-Type 2 (CODE-2) study²⁵ in eight European countries attributed the largest portion of medical costs to hospital admissions (55%), with only a small portion accounted for by

Table 4 | Itemized Direct medical costs among diabetes patients with or without complications in 2015

Variable	Without complications			With complications			Z, P-value
	n	Median (P25–P75)	Mean (SD)	n	Median (P25–P75)	Mean (SD)	
Total	14,346	942 (353–2,211)	1,878 (2,914)	2,329	3,257 (994–9,263)	9,382 (26,491)	35.096, <0.001
Inpatient admission	709	5,913 (4,494–7,717)	7,330 (6,134)	839	8,955 (6,005–17,257)	19,699 (41,158)	14.205, <0.001
Outpatient visit	14,299	904 (345–2,011)	1,521 (1,848)	2,262	1,515 (612–3,324)	2,352 (2,457)	18.266, <0.001
Pharmaceuticals	13,544	883 (334–2,045)	1,585 (2,169)	2,310	2,440 (806–5,282)	4,897 (12,920)	29.641, <0.001
Diagnostic test	11,230	45 (18–144)	272 (742)	1,985	442 (66–2,640)	1,829 (3,803)	35.825, <0.001
Surgery	68	150 (12–1,081)	693 (1,126)	175	1,650 (80–4,025)	2,622 (3,233)	–5.469, <0.001
Non-surgical procedure	13,258	50 (20–90)	115 (485)	2,172	111 (36–724)	1,473 (9,480)	27.132, <0.001
Material	6,834	9 (3–88)	114 (721)	1,692	92 (13–360)	1,626 (10,553)	24.556, <0.001
Room	748	360 (243–495)	452 (578)	853	480 (282–836)	1,037 (2,096)	–8.963, <0.001
Others	813	214 (92–350)	282 (390)	878	280 (140–540)	737 (2,287)	–7.482, <0.001
Proportion of OOP (%)	42.27			37.70			

Costs are in Chinese Yuan. OOP, out of pocket; SD, standard deviation.

medications (4%). A study in the USA also showed that the largest share of expenditures was for hospital admissions (50%), followed by medications and medical supplies (12%)²⁶. However, the present finding is similar to that of a study in Brazil, which found the greatest single category of direct outpatient costs was medications (48.2%)²⁷. Similarly, the cost of drugs was reported separately in the majority of studies (65%) in African countries²⁸. The present results are also consistent with the pattern reported in a previous study, that in high-income countries, only approximately one-quarter of the medical expenditures for diabetes is for control of blood glucose concentrations, whereas in low-income countries it is roughly half¹.

In the current study, hospital-based care for patients with diabetes absorbed 78.06% of type 2 diabetes mellitus-related DMC. The median total cost and OOP cost for hospital-based care was 3.69- and 4.26-fold higher, respectively, than that for primary care. Diabetes has become a common chronic disease in China; most patients could be better managed within the community, at lower expense, than with hospital-based care, especially at high-priced tertiary hospitals. Therefore, reforms designed to entice patients to community health centers, by reassuring patients about the quality of care and providing incentives for primary care management, hold promise for substantially reducing the increases in resource use associated with the increasing prevalence of diabetes in China, while maintaining or improving the quality of life for these patients.

We found that complications obviously aggravated the economic burden of type 2 diabetes mellitus. In patients with complications, the median DMC was 3.46-fold higher than for patients without complications. The median DMC for a patient with only macrovascular, only microvascular or both macrovascular and microvascular complications were 3.13-, 3.79- and 10.95-fold higher than that of patients without complications. This finding is in concordance with a study carried out in the United Arab Emirates, which found that the cost increased 6.4-, 2.2- and 9.4-fold, respectively, with the presence of

macrovascular complications, microvascular complications, and both micro- and macrovascular complications²⁹. Many previous studies reported that the proportion of macrovascular complications only was less than only microvascular complications¹⁹, the cost for patients with both macro- and microvascular complications was highest, followed by only macrovascular complications and then only microvascular complications²⁴. In contrast, we found patients with macrovascular complications accounted for the greatest proportion of complications, and the median cost for only microvascular was higher than only macrovascular. Similarly, a study in Thailand also showed the median cost for only microvascular complications was higher compared with only macrovascular complications³⁰. The difference might be due to the inclusion of patients with stroke and ischemic heart disease sequela, or at related recovery periods, they pay far less than at the onset of macrovascular complications. It also implied that the undiagnosed rate of microvascular complications was high, and that the screen for microvascular complications is necessary in rural China.

On average, 40.23% of annual DMC is paid OOP. For patients with URBMI, OOP costs accounted for a higher proportion of DMC than for those with UEBMI (46.28 vs 25.71%). Furthermore, the proportion of OOP expenses is higher among outpatient costs than inpatient costs (45.14 vs 34.11%). This finding is similar to Wang's study of urban China, which showed 42.1% of annual DMC was OOP payments²⁴. Additionally, we found that for patients without complications, 42.27% of total costs were paid OOP, compared with 37.70% for those with complications. By contrast, in urban China, patients with complications paid more OOP than those without (44.6 vs 40.4%)²⁴. These differences can be explained by the basic medical insurance benefit packages in China, as exemplified in Tongxiang. UEBMI is more generous than URBMI, and hospital admissions generally have a higher reimbursement ratio than outpatient visits do. Patients with complications often can be severely ill and require hospitalization.

Furthermore, some recent policies in Tongxiang (such as diabetes was identified as a special disease covered for inpatient and outpatient services, and catastrophic insurance for high spending) have reduced the OOP costs.

The present study had several limitations that should be noted. First, the sample cannot be considered representative of rural China as a whole. We derived the studied individuals from the Tongxiang diabetes management system, and with insurance claims of antidiabetes treatment. Second, we used the first diagnosis listed in the insurance claim to define the primary reason for each inpatient admission or outpatient visit. Therefore, we only imperfectly distinguished the allocation of total expenditures between diabetes-related and non diabetes-related causes. Third, the URBMI in Tongxiang did not collect the information on self-medication, and the self-medication records in UEBMI were limited. Thus, the present study might underestimate the DMC. Fourth, we defined patients with complications as those who had at least one claim for a complication in the social security system in 2015. This might lead to an underestimation of complications and thus of their associated costs. Finally, we described and compared costs among different categories directly, and the cost ratios might be confounded by potential confounders.

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DISCLOSURE

The authors declare no conflict of interest.

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