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# Comparing the Economic Burden of Type 2 Diabetes Mellitus Patients with and without Medical Insurance: A Cross-Sectional Study in China

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**Background:** The burden of diabetes has become a worldwide public health issue. Previous studies focused on the composition and influencing factors of hospitalization costs for insured patients. The aim of this study was to compare the economic burden of diabetic patients with and without medical insurance (MI) in China, from the aspects of types of medical costs and diabetic comorbidities.





**Material/Methods:** We identified 124 701 patients with type 2 diabetes mellitus in 2015 from electronic Hospitalization Summary Reports. The information on demographics, comorbidities, and hospitalization costs were extracted and evaluated. Differences between groups were analyzed by Mann-Whitney *U* test.

**Results:** The mean age of patients was 58.0±13.4 years. Hypertensive diseases (63.5%), ischemic heart diseases (21.3%), and chronic kidney disease (17.5%) were the most common comorbidities. The median hospitalization costs for diabetic patients with and without MI were 9485.0 RMB and 9104.0 RMB, respectively. The insured patients' median out-of-pocket (OOP) cost was 1601.3 RMB, and they incurred more costs for laboratory tests, imaging examinations, and medical services, and less costs for prescribed drugs (*p*<0.05). Insured patients had higher costs when associated with hypertensive diseases, cerebrovascular diseases, and ischemic heart diseases (*p*<0.05).

**Conclusions:** Diabetic patients with MI have higher hospitalization costs than those without MI, but uninsured patients carry a heavier OOP burden. The MI system in China needs further improvement to reduce the economic burden of diabetes.

**MeSH Keywords:** **Costs and Cost Analysis • Diabetes Mellitus • Hospitalization • Insurance**

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## Background

Diabetes is one of the most common and costly chronic diseases, the burden of which has become an important public health issue all over the world [1]. The prevalence of diabetes is increasing yearly. According to the International Diabetes Federation, there are currently 415 million people living with diabetes, and this number is predicted to increase to 642 million by 2040 [2]. China has the world's largest diabetes epidemic. Updated data show that the estimated overall prevalence of diabetes and prediabetes in Chinese adults is 10.9% and 35.7%, respectively [3]. Moreover, the direct medical costs of type 2 diabetes mellitus (T2DM) in China increased at an annual rate of 19.9% between 1993 and 2003 [4], which imposed a heavy economic burden on those patients. Hospitalization costs of diabetes and its comorbidities are the main sources of total costs [5].

China has established basic medical insurance (MI) schemes since 1994, aiming to provide greater financial protection to insured people [6]. The insurance is categorized into 3 main types: Urban Employee's Basic Medical Insurance (UEBMI) for the urban working population; Urban Resident Basic Medical Insurance (URBMI), which aims to cover urban residents who are not employed; and the New Rural Cooperative Medical System (NCMS), a voluntary system intending to provide financial subsidies for rural residents [7]. The national coverage of basic MI currently exceeds 90% [8]. There have been a number of studies on hospitalization costs of T2DM patients in China. However, most of them focused on the composition and influencing factors of medical expenses, and the study populations were restricted to MI participants [9–11]. Few studies have compared the hospitalization costs of diabetic patients from the perspective of whether they are participating in MI, especially utilizing a large dataset.

In the present study, using electronic Hospitalization Summary Reports (HSRs) of patients with T2DM in China in 2015, we analyzed the economic burden of patients with or without MI, from the aspects of types of medical costs and diabetic comorbidities. Our aim was to evaluate the influence of the MI system on hospitalization costs for diabetic patients, and to provide some suggestions for reducing the disease burden associated with diabetes in China.

## Material and Methods

### Data source

Data were extracted from the HSRs in 100 Grade 3A hospitals in China in 2015. Both public and private hospitals in China are classified into 3 grades and 10 classes, ranked by their medical

services and management, quality and safety of clinical care, and technical level and efficiency. Grade 3A is the highest rank. The HSRs must be electronically submitted to a centralized health information system, in accordance with the administrative requirements of the China Ministry of Health [9]. The electronic HSRs are documented with demographics, dates of admission and discharge, pre- and post-hospitalization diagnoses (1 primary diagnosis and 10 comorbid conditions) and the corresponding International Classification of Diseases, 10th Revision (ICD-10) codes, treatments, and hospitalization costs for inpatients. The present secondary data analysis was considered exempt from ethics review as it used data collected for administrative purposes without any personal identifiers.

### Study population

Hospitalized patients with T2DM in 2015 were identified if the primary discharge diagnosis ICD-10 codes were E11.0–E11.9. To minimize the influence of coding inaccuracy, the corresponding diagnoses were used to check the identified T2DM patients. Major chronic comorbidities, including hypertensive diseases (I10–I15), cerebrovascular diseases (I60–I69), ischemic heart diseases (I20–I25), chronic obstructive pulmonary disease (COPD) (J40–J44), and chronic kidney disease (CKD) (N18–N19), were also identified.

Patients who were aged  $\geq 18$  years and had at least 1 day of hospitalization were eligible for inclusion in this study, and we excluded patients who were under the management of socialized medicine (free medical service). In total, we identified 124 701 qualified T2DM patients in 100 hospitals across China. All eligible patients had data available regarding age, sex, type of MI, admission time, length of stay (LOS), diagnosis, and hospitalization costs. Cost information contained total cost and the allocated costs, including cost covered by basic MI schemes, and by patients themselves, labeled out-of-pocket (OOP) payment.

### Statistical analysis

Continuous data are presented as mean  $\pm$  standard deviation, or as median (inter-quartile range, IQR) for highly skewed variables. Categorical variables are presented as proportions, and were analyzed using the chi-square test. Patients were divided into 2 groups: patients with MI (UEBMI, URBMI, NCMS, and other types of commercial insurance), or patients without MI. The Mann-Whitney *U* test was used to compare the distributions of medical costs and LOS between groups. Differences were considered statistically significant when two-tailed  $p < 0.05$ . All statistical analyses were performed using SAS software, version 9.4 (SAS Institute Inc, Cary, NC).

**Table 1.** Demographic characteristics of T2DM patients.

Variable	With MI [n (%)]				Without MI [n (%)]	Total [n (%)]
	UEBMI	URBMI	NCMS	Others		
Gender						
Male	36806 (60.5)	5517 (50.8)	5632 (50.2)	12419 (61.9)	13403 (61.8)	73777 (59.2)
Female	24067 (39.5)	5336 (49.2)	5593 (49.8)	7638 (38.1)	8290 (38.2)	50924 (40.8)
Age group (years)						
<40	4544 (7.5)	961 (8.9)	1159 (10.3)	1468 (7.3)	2402 (11.1)	10534 (8.5)
40–59	26466 (43.5)	4629 (42.7)	5774 (51.4)	8646 (43.1)	10766 (49.6)	56281 (45.1)
≥60	29863 (49.1)	5263 (48.5)	4292 (38.2)	9943 (49.6)	8525 (39.3)	57886 (46.4)
No. admissions						
1	41416 (68.0)	7683 (70.8)	9110 (81.2)	14075 (70.2)	17731 (81.7)	90015 (72.2)
≥2	19457 (32.0)	3170 (29.2)	2115 (18.8)	5982 (29.8)	3962 (18.3)	34686 (27.8)
Comorbidity						
Hypertensive disease	38922 (63.9)	6835 (63.0)	6717 (59.8)	12397 (61.8)	14320 (66.0)	79191 (63.5)
Cerebrovascular disease	983 (1.6)	154 (1.4)	159 (1.4)	280 (1.4)	305 (1.4)	1881 (1.5)
Ischemic heart disease	13330 (21.9)	2350 (21.7)	2238 (19.9)	4494 (22.4)	4143 (19.1)	26555 (21.3)
COPD	614 (1.0)	104 (1.0)	135 (1.2)	153 (0.8)	159 (0.7)	1165 (0.9)
CKD	11031 (18.1)	2263 (20.9)	1785 (15.9)	3616 (18.0)	3173 (14.6)	21868 (17.5)
Total	60873	10853	11225	20057	21693	124701

MI – medical insurance; NCMS – New Rural Cooperative Medical System; T2DM – type 2 diabetes mellitus; UEBMI – Urban Employee's Basic Medical Insurance; URBMI – Urban Resident Basic Medical Insurance; COPD – chronic obstructive pulmonary disease; CKD – chronic kidney disease.

## Results

A summary of demographic characteristics regarding the 124 701 T2DM patients with different types of MI is provided in Table 1. The proportion of male patients (59.2%) was higher than that of female patients (40.8%). The mean age was  $58.0 \pm 13.4$  years, with the  $\geq 40$  years age group accounting for 91.5% of the total. Compared with insured patients (70.2%), those without MI were most likely to be admitted only once (81.7%). The most common comorbidities were hypertensive diseases (63.5%), ischemic heart diseases (21.3%), and CKD (17.5%).

The per capita hospital visits of patients with or without MI were not significantly different (both 1.1 times/person-year), while patients without MI had a higher rate of emergency referral and a shorter LOS (15.3% versus 9.4%,  $p < 0.05$ ; 11.0 days versus 14.0 days,  $p < 0.01$ ).

Table 2 lists the median total hospitalization costs and different types of costs for T2DM patients. The median hospitalization

costs per visit for patients with or without MI were 9485.0 RMB (IQR: 6817.0–13162.0 RMB) and 9104.0 RMB (IQR: 6448.0–13125.5 RMB), respectively. The median OOP cost of the former was 1601.3 RMB (IQR: 0–6795.0 RMB), accounting for 16.9% and 17.6% of total costs of the 2 groups, respectively.

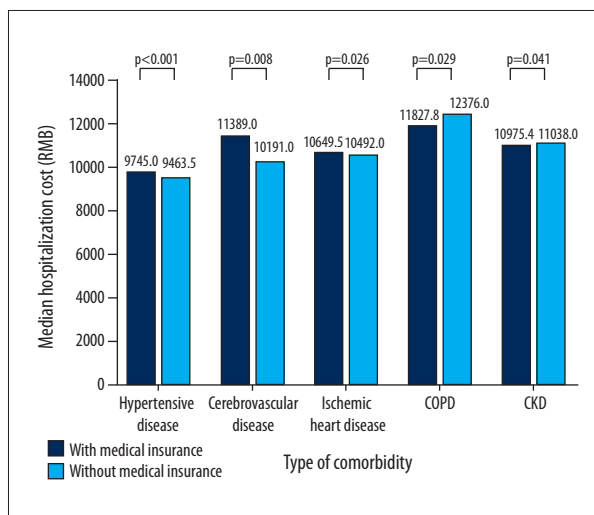
The expenses for laboratory tests, imaging examinations, and general medical services of patients with MI were higher than those without MI, while the latter had higher expenses for prescribed drugs ( $p < 0.05$ , Table 2).

Hospitalization costs increased significantly in both insured and uninsured patients with any type of comorbidity ( $p < 0.05$ , data are not shown). Figure 1 shows the median hospitalization costs of T2DM patients with different comorbidities. Insured patients had higher costs when associated with hypertensive diseases, cerebrovascular diseases, and ischemic heart diseases ( $p < 0.05$ ). However, when combined with COPD and CKD, uninsured patients incurred higher hospitalization costs than insured patients ( $p < 0.05$ ).

**Table 2.** Median (IQR) hospitalization costs of T2DM patients.

	Total costs (RMB)	General medical service costs (RMB)	Laboratory test costs (RMB)	Imaging examination costs (RMB)	Prescribed drug costs (RMB)
Total	9418.0 (6755.0, 13156.3)	416.0 (255.0, 694.0)	1978.0 (1209.0, 2918.0)	1040.0 (455.0, 1738.0)	3041.0 (1262.0, 5457.0)
With MI	9485.0 (6817.0, 13162.0)	425.0 (266.0, 706.0)	2036.0 (1235.5, 2972.0)	1059.0 (464.0, 1760.0)	3022.0 (1246.0, 5409.0)
Without MI	9104.0 (6448.0, 13125.5)	360.0 (208.0, 628.0)	1723.0 (1120.3, 2572.8)	964.0 (410.0, 1625.0)	3151.0 (1361.4, 5734.9)
p-Value	<0.001	0.027	<0.001	0.015	0.022

IQR – inter-quartile range; MI – medical insurance; RMB – Renminbi; T2DM – type 2 diabetes mellitus.



**Figure 1.** Median hospitalization costs of T2DM patients with specific types of comorbidities. CKD – chronic kidney disease; COPD – chronic obstructive pulmonary disease; RMB – Renminbi; T2DM – type 2 diabetes mellitus.

## Discussion

This is the first study comparing the economic burden of T2DM patients with and without MI in China, using a large dataset of HSRs. Our study indicates that the hospitalization costs of insured T2DM patients were higher than those of uninsured patients, especially costs for laboratory tests, imaging examinations, and medical services, and when patients were associated with hypertensive diseases, cerebrovascular diseases, and ischemic heart diseases. However, the OOP costs of patients with MI accounted for no more than 20% of total hospitalization costs. The results of our study could help improve the current MI system, expand the coverage of basic MI, and alleviate the disease burden of diabetes.

There are many studies on the medical expenses of diabetic patients. Data from 2015 estimated that the worldwide average

annual cost of treating and managing diabetes was \$1622 to \$2886 per person [2]. The results of a study using electronic insurance claims data in China showed an increasing trend in total medical costs (from \$2383 to \$2780) between 2009 and 2011 [10]. Our results were close to the aforementioned results, and showed that the median hospitalization costs for T2DM patients with or without MI were 9485.0 RMB and 9104.0 RMB, respectively. A study in Asia found that uninsured patients had significantly lower medical spending than insured patients, especially in the countries with large OOP financing burdens such as India and China [12]. Another study in China found that the hospitalization cost of insured patients (12 699.8 RMB) were far higher than those of uninsured patients (8463.9 RMB) [13]. The reasons for these differences may be: 1) compared to patients without MI, patients with MI prefer better medical services and treatments due to the sound medical security system in China, but this may lead to excessive consumption of medical resources; and 2) previous studies are restricted to a single city or hospital, while the economic development level and medical security policy vary greatly in different regions. Our study included 200 hospitals in China, with wide coverage and good representativeness, making the results more credible.

In terms of specific types of expenses, costs for laboratory tests, imaging examinations, and general medical services of patients with MI were higher than for those without MI. Insured patients may undergo more laboratory tests and examinations within the scope of MI reimbursement. Thus, this could affect doctors' clinical practice and lead to excessive examinations for insured patients. However, uninsured patients had higher costs for prescribed drugs than did insured patients. This may be because: 1) drug pricing in the MI directory is relatively low, and physicians' prescription behaviors are regulated to provide inexpensive biomedicines by a comprehensive medicine policy reform launched in 2009 [10]; and 2) some patients without MI are medical immigrants from other regions, so they may request doctors to overprescribe. In addition, our results showed that the proportions of major

comorbidities in diabetic patients were similar to those of previous studies [10,14,15]. Prevalences of diabetic comorbidities, plus their median medical costs, were the reflection of the overall economic burden for diabetic patients with different comorbidities. Hospitalization costs were higher for patients with cardiovascular diseases when they had MI. Diabetes-related comorbidities showed a significant impact on healthcare costs [16,17]. Therefore, to reasonably control medical costs of patients with diabetes, national awareness of prevention should be improved. Moreover, it is important to standardize medical behaviors and processes while shortening LOS [9], to strengthen the supervision of the MI fund, and ultimately to reduce the waste of medical resources.

Our study does have some limitations. First, despite quality controls, there may be some measurement errors in ICD-10 codes, which could cause misclassifications of T2DM and other comorbidities when identifying patients. Second, information on glucose, blood pressure, insulin, and other drugs was not available, but these factors could have a significant influence on diabetic comorbidities and hospitalization costs [18]. Finally, we only compared the economic burden of patients

with and without MI, and preliminarily analyzed the corresponding reasons. Further studies should include more socio-economic factors, and carry out in-depth policy research and health economics evaluation.

## Conclusions

Diabetic patients with MI have higher hospitalization costs than those without MI, especially costs for laboratory tests, imaging examinations, and medical services, but uninsured patients carry a heavier OOP burden. Chronic comorbidities are associated with increased hospitalization costs in T2DM patients. To reduce the economic burden of diabetes, the MI system in China needs further improvement, including the expansion of coverage and reimbursement directory. In addition, it is necessary to avoid overuse and waste of medical resources.

## Conflicts of interest

None.

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