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Healthcare resource utilization, direct medical costs, and the temporal trends for patients with major depressive disorder in China: a 6-year retrospective analysis

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Abstract

Background

Major depressive disorder (MDD), the second leading cause of non-fatal disability globally, poses a growing public health challenge in China. Despite its significant burden, updated evidence on healthcare resource utilization patterns, direct medical costs, and temporal trends remains scarce. This study addresses this critical knowledge gap.

Methods

This retrospective observational study extracted electronic medical records from the hospital information system in Nanshan District, Shenzhen City, between 2018 and 2023, by using pre-defined international disease codes. Analyses on healthcare utilization and direct medical costs were conducted at both the encounter level and the individual level. A bottom-up approach was employed for cost estimation, with a generalized linear model to identify cost-associated factors.

Results

Among 32,421 unique patients (77,213 records), the annual per-capita emergency, outpatient, and inpatient visits were, respectively, 1.06, 2.42, and 1.19 times, incurring corresponding direct medical costs of 118.2, 148.94, and 2,289.54 USD. The mean hospitalization durations was 0.72 days overall and 13.06 days for admitted patients. Most patients utilized tertiary hospitals (93.8%) and were treated in mental health specialties (80.3%). From 2018 to 2023, the ratio of psychiatry and general medicine visits increased, while annual direct medical costs for outpatient visits and tertiary hospital utilization declined. Age, gender, length of stay, hospital level, and comorbidity number were significantly associated with direct medical costs at the patient level (all $P < 0.05$).

Conclusions

This study indicates the undertreatment of MDD in urban China, especially in the outpatient services. From the perspective of the healthcare system, MDD imposes significant economic burdens for admitted patients, with tertiary hospitals serving as the primary providers of depression-related services. These findings underscore the urgency for policies to: (1) strengthen primary care capacity for depression management and improve the corresponding reimbursement mechanisms, (2) optimize the dual referral system across hospital tiers, and (3) implement cost-effective early intervention strategies within China's evolving mental health system.

Background

Major depressive disorder (MDD) is a debilitating mental health condition featured by persistent low mood, loss of pleasure, suicidal ideation, and accompanying physical and cognitive symptoms.[1] According to the Global Burden of Disease 2019, MDD is ranked as the major cause of non-fatal disability.[2] The substantial disease burden not only places additional pressure on healthcare systems but also leads to negative societal impact (e.g., higher absenteeism rates and diminished productivity due to presenteeism). In 2019, the global direct healthcare spending on MDD is estimated to reach 174.6 billion US dollars (USD).[3] Moreover, it costs the global economy approximately 1 trillion USD due to lost productivity each year.[4] Now, MDD has become a major public health concern worldwide.

In China, the 12-month prevalence of MDD was 3.6%, with projections indicating a continued rise in incidence.[5, 6] However, the treatment rate was relatively low, with merely 9.5% of affected individuals receiving care. Additionally, only 0.5% patients received adequate care.[7] This pronounced treatment gap underscores the critical need to examine healthcare resource utilization among Chinese patients with MDD. Existing research has extensively investigated healthcare resource utilization rates across diverse geographical contexts. In high-income countries, utilization rates are notably higher. For instance, in the United States, patients with MDD averaged 1.31 emergency visits, 22.68 outpatient visits, and 0.19 inpatient visits annually.[8] Similarly, a Swedish population-wide observational study reported an annual average of 7.90 outpatient visits per patient with incident MDD,[9] while Hungarian data indicated medians of 7.3 (IQR: 3.5–14.7) outpatient visits and 0.5 (IQR: 0.2–1.0) inpatient visits per year.[10] In contrast, healthcare resource utilization among MDD patients in low- and middle-income countries (LMICs) remains substantially lower, reflecting systemic disparities in mental healthcare access. For example, in Nepal, the median annual number of both outpatient and inpatient visits was strikingly low at 0 (IQR: 0–4 and 0–0, respectively).[11] Data from China also reveal comparatively lower utilization rates, with an annual average of 2.90 outpatient visits and 1.35 inpatient visits per patient.[12] A slightly higher rate was observed among beneficiaries of China's Urban Employee Basic Medical Insurance (UEBMI), who averaged 3.1 outpatient visits annually.[13] However, existing Chinese studies face key limitations. The above two studies rely on UEBMI claims data from northern China, restricting generalizability to other regions and populations. Moreover, their focus was predominantly on visit frequency rather than utilization patterns, further underscoring the need for updated, comprehensive evaluations.

In addition, timely access to accurate data on cost-of-illness is essential for policymakers to allocate resources toward optimal prevention and treatment interventions. It is reported that patients with MDD are faced with high direct medical costs. In the United States, the average annual direct medical costs for emergency visits, outpatient visits, and inpatient visits were 974 USD, 6,609 USD, and 4,102 USD per patient in 2021[1,081 USD, 7,332 USD, and 4,551 USD in 2023], respectively.[14] Research conducted in Canada found that the average annual per-capita direct medical costs in the emergency, outpatient, and hospitalization sectors were 118 USD, 850 USD, and 1,014 USD in 2013 [124 USD, 892 USD, and 1,064 USD in 2023], respectively.[15] A study conducted in Spain reported that the mean direct medical costs per patient per year were 594.2 euros in 2017 [1,088 USD in 2023].[16] In Singapore, the direct annual

healthcare costs due to depression and anxiety symptoms averaged Singapore dollar (SGD) 1,050 [1,293 USD in 2023] for these MDDs.[17] In Iran, the annual direct medical costs per patient in 2020 were 1,492 USD [1,730 USD in 2023].[18] Estimates from a Chinese national survey indicate that depression and depressive symptoms constituted 14.7% of individual healthcare expenses in China.[19] Ding et al.,[12] performed estimations on per-capita annual direct medical costs for outpatient and inpatient visits by using 5% random sample of claims data mainly from UEBMI (56.8 USD and 1,427.4 USD in 2016 [71 USD and 1,781 USD in 2023]). However, the generalizability of existing studies may be limited, as most research samples are confined to UEBMI beneficiaries. Furthermore, no studies to date have examined temporal trends in medical expenditures or their cost composition in the Chinese context.

To provide essential evidence for optimizing mental health resource allocation in China's evolving healthcare landscape, the objectives of this study were to (1) characterize healthcare access and utilization patterns among Chinese patients with MDD, (2) evaluate associated direct medical costs and key cost drivers, and (3) explore the temporal trends.

Methods

Study design and data source

This retrospective observational study was conducted among patients with MDD in Shenzhen, China, by utilizing de-identified electronic medical records from the Shenzhen Nanshan Medical Group's Hospital Information System from January 1, 2018 to December 31, 2023. The healthcare group, governed by the Nanshan District Health Bureau and serving nearly 1.82 million in Nanshan, employs an innovative "1 + C + N" organizational model consisting of: (1) eighty-one primary healthcare centers; (2) four major district hospitals and two public health organizations; and (3) additional regional healthcare providers.[20, 21] This structure enables optimized resource allocation, standardized quality management, system-wide efficiency, and data sharing through integrated care. Access to raw data was restricted to authorized personnel approved by the institutional governance committee, with all analyses performed in this study using de-identified datasets.

Study population

The study population included patients diagnosed with MDD, identified using the International Classification of Diseases, 10th Revision (ICD-10 codes: F32.X and F33.X).[22] We excluded individuals without an MDD diagnosis, as well as those with comorbid mania, bipolar disorder, schizophrenia, postpartum depression, dementia, or psychosis. Additionally, records documenting healthcare resource utilization but lacking associated medical expenses were removed.

Measures and estimation

Information on demographic characteristics (i.e., age and gender), clinical profiles (i.e., hospital level, length of stay, and comorbidity), healthcare resource utilization, and associated costs was extracted from the electronic medical records at the patient level.

Healthcare resource utilization encompasses the patterns of healthcare service use within populations, including the frequency, type, and distribution of accessed departments. In this study, utilization was categorized into three types: emergency visits, outpatient visits, and inpatient visits. Utilization frequency was quantified as the annual number of visits per patient, stratified by service type and year. The utilization patterns were characterized by patient distribution across various medical departments, including general practice, psychiatry, neurology, traditional Chinese medicine, emergency, and other specialty departments.

Direct medical costs encompass all expenses directly associated with healthcare resource utilization, including: (1) western drug fees (costs of Western medications); (2) traditional Chinese drug fees (expenses for Chinese patent drugs and herbal medicines); (3) treatment and surgery fees (covering psychotherapy [e.g., cognitive behavioral therapy for MDD], medical consumables, physical therapy, oxygen therapy, anesthesia, blood transfusions, and other non-pharmacological interventions); (4) bed fees (inpatient accommodation charges); (5) laboratory and diagnostic fees (physical examinations and biochemical tests); and (6) other fees (miscellaneous services such as air conditioning). This study employed a healthcare system perspective and a bottom-up approach to calculate these costs,[23] with analyses conducted at both the patient and encounter level. All costs were adjusted to 2023 Chinese Yuan (CNY) values using China's national Consumer Price Index (CPI) to account for inflation.[24] Currency conversions were performed using the 2023 annual average exchange rate of 7.0467 CNY per 1 USD.[25]

Based on the Andersen behavioral model of health service use,[26] one of the most common use models of health service utilization, the potential impact factors of healthcare utilization and costs were selected from the following four parts: (1) contextual characteristics: health policy (i.e., year); (2) predisposing characteristics: age and gender; (3) enabling characteristics: hospital level classified according to the enacted regulation;[27] (4) need characteristics: length of stay and comorbidity (i.e., anxiety disorder, sleep disorder, somatic symptom disorder, obsessive compulsive disorder, attention deficit hyperactivity disorder, substance abuse, cardiovascular disease, cancer, chronic respiratory disease, diabetes).

Statistical analysis

All analyses were performed using R statistical software (version 4.4.3; R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics were used to characterize patient demographics, healthcare resource utilization patterns, and associated costs. Given the right-skewed distribution of outcome variables, continuous data are presented as mean ± standard deviation (SD) along with median (the lower and upper quantiles [Q1-Q3]). Categorical variables

are summarized as frequencies (percentages). For comparative analyses of healthcare utilization frequency and direct medical costs across study years, we employed Kruskal-Wallis non-parametric tests followed by Dunn's post hoc tests with Bonferroni adjustment for multiple comparisons. Temporal changes in healthcare utilization patterns and cost composition were assessed using Pearson's chi-square tests of independence. Temporal trends in Western drug expenditure proportions (expressed as a percentage of total direct medical costs) were analyzed using the non-parametric Mann-Kendall test, which is robust to non-normal distributions and able to detect monotonic trends without assuming linearity. The magnitude of trends was quantified by Sen's slope estimator with 95% confidence intervals. To identify factors associated with costs, we employed a generalized linear model (GLM) with a gamma distribution and a log-link function.[28–30] Statistical significance was defined as a two-tailed *P*-value < 0.05. For cost analyses, considering the impact and magnitude of the outliers, the top 0.1% of extreme values were excluded in the main analysis, while a sensitivity analysis was performed excluding the top 1% of values.[31]

Results

From January 1, 2018 to December 31, 2023, we identified 84,703 medical records with a primary diagnosis of MDD according to the pre-defined ICD-10 codes in Nanshan District, Shenzhen. After applying inclusion and exclusion criteria, 77,213 records (91.2%) were included in the final analysis. Exclusions comprised 5,764 records (6.8%) that fulfilled the exclusion criteria and 1,726 records (2.0%) lacking cost data. These records represented 32,421 unique patients. Figure 1 illustrates the detailed patient selection process.

Patient characteristics

This study included 32,421 patients diagnosed with MDD. As described in Table 1, the sample had a mean age of 35.3 years (SD = 16.9) with a 2:1 female-to-male ratio. The majority (52.6%) of patients were young adults aged 18–35 years. Comorbid conditions were prevalent, affecting 25.9% of the study population. Psychiatric comorbidities were most frequently observed, including sleep disorders (12.6%) and anxiety disorders (9.9%). Among non-psychiatric conditions, cardiovascular diseases (6.9%) represented the most common comorbidity. The annual distribution of cases showed a progressive increase from 2018 to 2023, with proportions of 10.0%, 15.8%, 14.4%, 19.2%, 17.7%, and 22.9%, respectively.

Table 1
Characteristics of patients with major depressive disorder

Variable	**Overall(n = 32,421)**
Age **mean (SD)**, years	35.28 (16.88)
Age group	
< 18	3036 (9.4)
18 ≤ Age < 35	17057 (52.6)
35 ≤ Age < 45	4200 (13.0)
45 ≤ Age < 55	3063 (9.4)
55 ≤ Age < 65	2278 (7.0)
≥ 65	2784 (8.6)
Not available	3
Gender, n (%)	
Female	21668 (66.8)
Male	10752 (33.2)
Not available	1
Length of stay (days) **mean (SD)**	0.72 (8.09)
Hospital level, n (%)	
Primary	943 (2.9)
Secondary	1068 (3.3)
Tertiary	30410 (93.8)
Comorbidity condition, n (%)	8404 (25.9)
Comorbidity number **mean (SD)**	0.33 (0.63)
Anxiety disorder, n (%)	3197 (9.9)
Sleep disorder, n (%)	4091 (12.6)
Somatic symptom disorder, n (%)	84 (0.3)
Obsessive-compulsive disorder, n (%)	112 (0.3)
Attention deficit hyperactivity disorder, n (%)	80 (0.2)
Substance abuse, n (%)	25 (0.1)
Cardiovascular disease, n (%)	2221 (6.9)
Cancer, n (%)	247 (0.8)
Chronic respiratory disease, n (%)	145 (0.4)
Diabetes, n (%)	739 (2.3)
Year, n (%)	
2018	3245 (10.0)
2019	5131 (15.8)
2020	4664 (14.4)
2021	6228 (19.2)
2022	5741 (17.7)
2023	7412 (22.9)

Healthcare resource utilization

At the patient level, the annual average emergency visits, outpatient visits, and inpatient visits were 1.06 times (SD = 0.27), 2.42 times (SD = 2.60), and 1.19 times (SD = 1.00), respectively. Detailed information on healthcare resource utilization by study time is presented in Table 2. The average length of stay per patient year was 0.72 days (SD = 8.09), while among those who utilized hospitalization services, the value reached 13.06 days (SD = 34.04). The majority (93.8%) of patients seek healthcare in tertiary hospitals, followed by secondary (3.3%) and primary hospitals (2.9%). From 2018 to 2023, there were no

significant changes in the annual per capita frequency of emergency visits ($P = 0.79$) or inpatient visits ($P = 0.61$), as determined by Kruskal-Wallis tests. In contrast, outpatient visit frequency varied significantly across years ($P < 0.001$), with post-hoc Dunn tests revealing that the highest utilization occurred in 2018 (2.88 (SD = 3.56) visits/year) compared to subsequent years (all adjusted *P values less than* 0.05).

Table 2
Annual healthcare resource utilization frequency of patients with major depressive disorder

Year	Healthcare utilization type	mean (SD)	median (Q1-Q3)
2018	Emergency visits	not available	not available
	Outpatient visits	2.88 (3.56)	1 (1–3)
	Inpatient visits	1.17 (0.66)	1 (1–1)
2019	Emergency visits	not available	not available
	Outpatient visits	2.52 (2.77)	1 (1–3)
	Inpatient visits	1.13 (0.55)	1 (1–1)
2020	Emergency visits	1.00 (0.00)	1 (1–1)
	Outpatient visits	2.48 (2.61)	1 (1–3)
	Inpatient visits	1.21 (1.01)	1 (1–1)
2021	Emergency visits	1.04 (0.20)	1 (1–1)
	Outpatient visits	2.37 (2.38)	1 (1–3)
	Inpatient visits	1.19 (1.02)	1 (1–1)
2022	Emergency visits	1.07 (0.30)	1 (1–1)
	Outpatient visits	2.33 (2.31)	1 (1–3)
	Inpatient visits	1.21 (0.97)	1 (1–1)
2023	Emergency visits	1.05 (0.27)	1 (1–1)
	Outpatient visits	2.23 (2.28)	1 (1–3)
	Inpatient visits	1.22 (1.23)	1 (1–1)
Total			
	Emergency visits	1.06 (0.27)	1 (1–1)
	Outpatient visits	2.42 (2.60)	1 (1–3)
	Inpatient visits	1.19 (1.00)	1 (1–1)

The average length of stay per encounter was 10.93 days (SD = 27.94). The majority of encounters (93.2%) occurred in tertiary hospitals, although this proportion exhibited a statistically significant decline from 2018 to 2023 ($P < 0.001$) (see Table 3). Regarding healthcare service utilization by department, psychiatry or psychology departments accounted for the highest proportion of visits (80.3%), followed by neurology (6.7%) and general practice clinics (3.2%). Notably, between 2018 and 2023, the proportions of visits to psychiatry or psychology departments and general practice clinics demonstrated gradual but significant increases ($P < 0.001$), as illustrated in Fig. 2.

Table 3
Healthcare resource utilization patterns of patients with major depressive disorder

Variable	2018	2019	2020	2021	2022	2023	*P* value
The distribution of hospitals at all levels, n (%)							< 0.001
Primary hospitals	116 (1.3)	266 (2.1)	301 (2.6)	474 (3.3)	404 (3.1)	424 (2.6)	
Secondary hospitals	155 (1.7)	176 (1.4)	122 (1.1)	803 (5.6)	1013 (7.7)	1008 (6.2)	
Tertiary hospitals	8934 (97.1)	12284 (96.5)	10974 (96.3)	13180 (91.2)	11713 (89.2)	14866 (91.2)	
The distribution of departments of healthcare utilization, n (%)							< 0.001
Department of Psychiatry	7042 (76.5)	9920 (78)	9016 (79.1)	11859 (82)	10565 (80.5)	13600 (83.4)	
General practice clinic	208 (2.3)	349 (2.7)	331 (2.9)	483 (3.3)	527 (4)	606 (3.7)	
Department of Neurology	1192 (12.9)	1241 (9.8)	803 (7)	739 (5.1)	613 (4.7)	562 (3.4)	
Traditional Chinese medicine clinic	86 (0.9)	99 (0.8)	147 (1.3)	207 (1.4)	158 (1.2)	171 (1)	
Department of Gastrology	42 (0.5)	74 (0.6)	54 (0.5)	37 (0.3)	56 (0.4)	62 (0.4)	
Emergency department	71 (0.8)	63 (0.5)	94 (0.8)	93 (0.6)	104 (0.8)	116 (0.7)	
Other	564 (6.1)	980 (7.7)	952 (8.4)	1039 (7.2)	1107 (8.4)	1181 (7.2)	

Direct medical costs and the itemized costs

Table 4 presents the aggregate direct costs stratified by healthcare resource utilization type and time, analyzed at both the encounter and patient levels. For patients with MDD, the mean direct medical costs per encounter were 788.24 CNY (SD = 884.86) [111.86 USD (SD = 125.57)] for emergency care, 431.77 CNY (SD = 671.64) [61.27 USD (SD = 95.31)] for outpatient visits, and 11,861.70 CNY (SD = 11,913.85) [1,683.3 USD (SD = 1,690.7)] for inpatient care. Annual per-capita costs averaged 832.99 CNY (SD = 906.07) [118.21 USD (SD = 128.58)] for emergency services, 1,049.55 CNY (SD = 1,701.50) [148.94 USD (SD = 241.46)] for outpatient care, and 16,133.71 CNY (SD = 22,198.93) [2,289.54 USD (SD = 3,150.26)] for hospitalizations.

Table 4
Average direct medical costs (Chinese Yuan, CNY) by healthcare resource utilization type

Year	Healthcare utilization type	Encounter-level		Patient-level	
		Costs mean (SD)	Costs median (Q1-Q3)	Costs mean (SD)	Costs median (Q1-Q3)
2018	Emergency visits	not available	not available	not available	not available
	Outpatient visits	398.84 (307.38)	320.03 (197.06-516.13)	1150.3 (1454.42)	646.73 (360.82-1309.27)
	Inpatient visits	11952.56 (12405.97)	8084.82 (5094.84-13070.28)	14870.96 (18109.23)	8883.44 (5181.21-14155.49)
2019	Emergency visits	not available	not available	not available	not available
	Outpatient visits	407.43 (321.02)	338.9 (223.1-503.24)	1025.44 (1247.63)	613.2 (353.48-1211.55)
	Inpatient visits	11601.09 (11514.75)	8081.71 (4752.69-13127.37)	14214.98 (16917.27)	8488.12 (5333.43-15223.78)
2020	Emergency visits	387.15 (190.44)	473.2 (458.95-475.28)	387.15 (190.44)	473.2 (458.95-475.28)
	Outpatient visits	449.03 (578.56)	369.12 (222.85-543.26)	1113.35 (1595.28)	641.25 (379.59-1274.18)
	Inpatient visits	12124.88 (12358.25)	7791.52 (4661.06-13928.41)	17178 (24847.52)	8043.42 (4794.6-15931.17)
2021	Emergency visits	883.08 (936.27)	714.65 (184.92-1164.59)	919.87 (962.03)	714.65 (172.85-1270.82)
	Outpatient visits	495.77 (931.35)	340.56 (172.66-566.49)	1173.92 (1878.8)	627.28 (386.13-1302.59)
	Inpatient visits	12009.16 (12011.99)	8610.67 (4729.54-13880.38)	16642.33 (23472.03)	8954.47 (4741.39-15805.28)
2022	Emergency visits	747.19 (865.96)	521.98 (233.2-1023.56)	802.83 (897.65)	588.88 (248.26-1085.85)
	Outpatient visits	431.58 (842.05)	274.94 (117.16-536.27)	1026.36 (2253.52)	601.95 (337.89-1109.18)
	Inpatient visits	11197.17 (11467.1)	7577.06 (4388.13-13534.61)	16243.71 (24099.31)	8496.32 (4793.58-16581.81)
2023	Emergency visits	804.64 (902.04)	663.53 (149.49-1073.37)	843.89 (910.49)	679.66 (302-1085.27)
	Outpatient visits	401.16 (657.83)	272.04 (124.5–531)	894.51 (1468.52)	606.03 (391-1004.67)
	Inpatient visits	12219.59 (12025.3)	7665.65 (4586.4-15083.56)	16393.39 (21470.67)	8061.51 (4760.23-18477.58)
Total					
	Emergency visits	788.24 (884.86)	588.88 (180.52-1065.11)	832.99 (906.07)	633.18 (248-1118.22)
	Outpatient visits	431.77 (671.64)	326.73 (174.05-533.77)	1049.55 (1701.5)	620.01 (369.76-1170.49)
	Inpatient visits	11861.7 (11913.85)	7923.75 (4619.65-13795.09)	16133.71 (22198.93)	8479.31 (4836.62-16296.84)

Statistical analysis revealed no significant interannual differences in per-capita costs for emergency visits ($P = 0.46$) or inpatient care ($P = 0.99$). However, costs for outpatient visits in 2022–2023 were significantly lower than those in 2018–2021 (Kruskal-Wallis test: $P < 0.001$; Dunn post hoc tests: adjusted $P < 0.001$ for the aforementioned pairwise comparisons).

The itemized per-visit and per-patient-year direct medical costs are listed in Tables 5 and 6, which exhibit a similar composition pattern. However, the cost composition varied substantially across different types of healthcare services, which is shown schematically in Fig. 3. For emergency visits, laboratory and diagnostic fees constituted the largest proportion (62.7%), followed by treatment and surgery fees (20.3%), Western drug fees (6.9%), other fees (5.8%), traditional Chinese drug fees (4.1%), and bed fees (0.2%). In contrast, outpatient visits were predominantly driven by Western drug fees (56.6%). Regarding inpatient visits, treatment and surgery fees accounted for the highest proportion (40.3%), with laboratory and diagnostic fees (36.3%), Western drug fees (17.0%), bed fees (5.3%), traditional Chinese drug fees (1.0%), and other fees (0.1%) contributing to the remaining costs.

Table 5
Components of per-encounter direct medical costs (Chinese Yuan) by healthcare resource utilization type

Year	Healthcare utilization type	Total Costs mean (SD)	Bed fees mean (SD)	Chinese drug fees mean (SD)	Western drug fees mean (SD)	Treatment and surgery fees mean (SD)	Laboratory and diagnostic fees mean (SD)	Other fees mean (SD)
2018	Emergency visits	not available	not available	not available	not available	not available	not available	not available
	Outpatient visits	398.84 (307.38)	0.01 (0.41)	3.91 (42.01)	278.43 (236.45)	35.91 (168.42)	80.47 (146.61)	0.11 (2.38)
	Inpatient visits	11952.56 (12405.97)	1027.92 (2129.32)	144.67 (366.45)	2708.57 (4607.57)	3640.95 (6818.51)	4407.57 (3293.67)	22.88 (36.19)
2019	Emergency visits	not available	not available	not available	not available	not available	not available	not available
	Outpatient visits	407.43 (321.02)	0 (0.29)	5.64 (47.39)	252.06 (234.78)	46.67 (177.95)	102.64 (165.32)	0.42 (12.62)
	Inpatient visits	11601.09 (11514.75)	725.42 (1323.11)	153.91 (326.75)	2599.18 (4214.83)	3804.59 (7441.64)	4298.07 (2946.53)	19.93 (150.44)
2020	Emergency visits	387.15 (190.44)	4.58 (10.23)	0 (0)	0 (0)	259.65 (154.94)	122.93 (56.27)	0 (0)
	Outpatient visits	449.03 (578.56)	0.01 (1.1)	8.8 (61.32)	295.03 (527.07)	44.38 (181.35)	100.07 (192.32)	0.74 (27.09)
	Inpatient visits	12124.88 (12358.25)	645.1 (1089.3)	131.35 (361.03)	2889.71 (5156.28)	4114.72 (7734.87)	4335.18 (3321.26)	8.83 (15.05)
2021	Emergency visits	883.08 (936.27)	2.44 (7.22)	110.28 (541.6)	86.6 (154.1)	158.12 (143.96)	473.26 (521.03)	52.38 (259.55)
	Outpatient visits	495.77 (931.35)	0.04 (2.2)	21.95 (188.46)	267.82 (820.44)	52.29 (212.24)	107.83 (186.45)	45.85 (276.83)
	Inpatient visits	12009.16 (12011.99)	668.36 (1043.29)	103.27 (259.82)	1990.4 (2927.5)	4617.7 (8790.87)	4612.7 (3463.5)	16.73 (98.86)
2022	Emergency visits	747.19 (865.96)	0.61 (2.88)	12.13 (36.54)	55.3 (130.61)	132.84 (148.34)	463.14 (479.53)	83.18 (560.05)
	Outpatient visits	431.58 (842.05)	0.05 (3.33)	16.77 (123.84)	216.49 (636.65)	59.44 (170.17)	99.74 (167.42)	39.09 (461.71)
	Inpatient visits	11197.17 (11467.1)	555.15 (1022.09)	116.24 (246.41)	1664.65 (3071.04)	4246.61 (8044.04)	4598 (3470.85)	16.52 (89.07)
2023	Emergency visits	804.64 (902.04)	1.84 (8.15)	11.8 (35.24)	38.73 (88.13)	186.45 (367.16)	564.9 (640.14)	0.93 (8.63)
	Outpatient visits	401.16 (657.83)	0 (0)	10.21 (83.41)	182.37 (474.69)	76.76 (231.61)	127.51 (224.72)	4.31 (296.45)
	Inpatient visits	12219.59 (12025.3)	657.52 (1292.22)	127.37 (272.47)	1404.81 (2586.05)	5030.18 (8088.28)	4987.49 (4142.78)	12.21 (20.45)
Total								
	Emergency visits	788.24(884.86)	1.51 (6.32)	32.04 (249.47)	54.73 (122.52)	159.73 (249.11)	494.36 (548.02)	45.87 (381.09)
	Outpatient visits	431.77(671.64)	0.02 (1.73)	11.77 (108.82)	243.97 (547.32)	54.53 (195.6)	105.26 (186)	16.22 (262.9)
	Inpatient visits	11861.7(11913.85)	671.34 (1250.43)	124.92 (292.92)	2022.69 (3600.3)	4413.04 (8039.98)	4614.41 (3568)	15.29 (82.31)

Table 6
Components of per-patient direct medical costs (Chinese Yuan) by healthcare resource utilization type

Year	Healthcare utilization type	Total costs mean (SD)	Bed fees mean (SD)	Chinese drug fees mean (SD)	Western drug fees mean (SD)	Treatment and surgery fees mean (SD)	Laboratory and diagnostic fees mean (SD)	Othe mea
2018	Emergency visits	not available	not available	not available	not available	not available	not available	not
	Outpatient visits	1150.3 (1454.42)	0.02 (0.7)	11.27 (117.82)	803.04 (1298.55)	103.57 (407.54)	232.09 (242.05)	0.31
	Inpatient visits	14870.96 (18109.23)	1211.18 (2488.93)	168.99 (396.09)	3206.03 (6232.26)	4987.14 (10846.59)	5270.25 (4609.18)	27.3
2019	Emergency visits	not available	not available	not available	not available	not available	not available	not
	Outpatient visits	1025.44 (1247.63)	0.01 (0.46)	14.19 (124.2)	634.39 (1111.45)	117.47 (351.73)	258.32 (240.98)	1.07
	Inpatient visits	14214.98 (16917.27)	842.75 (1442.49)	211.24 (587.16)	3355.23 (6703.36)	4773.68 (9427.3)	5008.54 (4205.51)	23.5 (159
2020	Emergency visits	387.15 (190.44)	4.58 (10.23)	0 (0)	0 (0)	259.65 (154.94)	122.93 (56.27)	0 (0
	Outpatient visits	1113.35 (1595.28)	0.03 (1.73)	21.82 (161.52)	731.52 (1472.99)	110.03 (396.58)	248.11 (291.94)	1.85
	Inpatient visits	17178 (24847.52)	815.74 (1338)	164.75 (400.57)	3469.2 (8098.4)	7122.82 (15810.25)	5593.76 (5613.16)	11.7
2021	Emergency visits	919.87 (962.03)	2.55 (7.35)	114.88 (552.51)	90.21 (156.98)	164.71 (156.06)	492.97 (540.6)	54.5 (264
	Outpatient visits	1173.92 (1878.8)	0.1 (3.38)	51.96 (318.34)	634.16 (1580.96)	123.81 (457.23)	255.33 (275.16)	108 (441
	Inpatient visits	16642.33 (23472.03)	850.32 (1446.12)	125.2 (299.38)	2716.64 (7206.19)	6929.44 (14738.55)	6000.22 (6174.89)	20.5
2022	Emergency visits	802.83 (897.65)	0.65 (2.98)	13.03 (42.45)	59.42 (136.68)	142.73 (154.79)	497.63 (490.93)	89.3 (580
	Outpatient visits	1026.36 (2253.52)	0.11 (5.09)	39.15 (264.72)	524.35 (1942.01)	138.73 (539.38)	232.78 (249.11)	91.2 (707
	Inpatient visits	16243.71 (24099.31)	671.63 (946.1)	143.66 (655.23)	2706.46 (8139.66)	6812.47 (15850.57)	5888.6 (5978.36)	20.8
2023	Emergency visits	843.89 (910.49)	1.93 (8.34)	12.38 (36)	40.62 (91.3)	195.54 (373.97)	592.45 (644.65)	0.98
	Outpatient visits	894.51 (1468.52)	0 (0)	22.78 (181.07)	406.65 (1041.7)	171.15 (627.79)	284.32 (334.07)	9.61
	Inpatient visits	16393.39 (21470.67)	964.06 (2865.43)	145.99 (389.75)	1938.13 (4533.82)	6882.38 (13348.07)	6446.47 (7014.17)	16.3
Total								
	Emergency visits	832.99(906.07)	1.59(6.49)	33.86(256.66)	57.84(126.74)	168.8(256.17)	522.43(558.52)	48.4
	Outpatient visits	1049.55(1701.5)	0.05(2.69)	28.52(216.56)	594.5(1443.33)	132.12(490.37)	255.05(280.42)	39.3
	Inpatient visits	16133.71(22198.93)	862.34(1903.22)	153.71(468.72)	2740.91(6865.82)	6504.13(13967.05)	5853.41(5982.77)	19.2

During the study period (2018–2023), a consistent downward trend was observed in the proportion of Western drug fees relative to total direct medical costs across all service categories. Notably, only the proportion in outpatient services exhibited the statistically significant reduction (24% decrease; $P = 0.024$), with an annual decrease rate of -4.68% [95% CI: -7.95%, -2.05%] as estimated by Sen's slope, whereas other service categories showed non-significant downward trends (emergency visit: $P = 1.00$; inpatient visit: $P = 0.60$).

The results of the sensitivity analysis of direct medical costs are shown in the Supplementary Materials, which further verify the robustness of the main analysis of costs.

Associated factors with direct medical costs

Table 7 presents the GLM results identifying key cost-driving factors for direct medical expenditures in patients with MDD. Multivariable analysis revealed that age, gender, length of stay, hospital level, and comorbidity number were significantly associated with direct medical costs at the patient level. After adjusting for potential confounders, we observed a positive correlation between advancing age and higher medical costs (β = 0.01, P < 0.001). Male patients incurred significantly greater expenditures than their female counterparts (β = 0.05, P = 0.009). Each additional day of hospitalization stay was associated with a 19.7% increase in costs (β = 0.18, P < 0.001). Treatment at tertiary hospitals resulted in higher costs compared to primary hospitals (β = 0.15, P = 0.003), whereas secondary hospitals showed reduced expenditures (β=-0.16, P = 0.020). Patients comorbid with more aforementioned diseases exhibited elevated costs (β = 0.19, P < 0.001).

Table 7
Factors associated with direct medical costs of major depressive disorder (GLM model)

Variable	Coef.	Adjusted std. error	P-value
Age	0.01	0.00	< 0.001
Gender			
Female (reference)			
Male	0.05	0.02	0.009
Length of stay(days)	0.18	0.00	< 0.001
Hospital level			
Primary (reference)			
Secondary	-0.16	0.07	0.020
Tertiary	0.15	0.05	0.003
Comorbidity number	0.19	0.02	< 0.001
Year			
2018 (reference)			
2019	-0.07	0.03	0.040
2020	-0.01	0.03	0.707
2021	0.07	0.03	0.034
2022	-0.09	0.03	0.006
2023	-0.22	0.03	< 0.001

Discussion

Principal findings

This study comprehensively analyzed healthcare utilization patterns, direct medical costs, and temporal trends among MDD patients using multi-tiered hospital records from Nanshan District, Shenzhen City, China. Results showed annual per-capita averages of 1.06 emergency visits (118.21 USD), 2.42 outpatient visits (148.94 USD), and 1.19 inpatient visits (2,289.54 USD), with mean hospitalization durations of 0.72 days overall and 13.06 days for admitted patients. Most patients (93.8%) utilized tertiary hospitals, primarily visiting psychiatry, neurology, and general medicine departments. The cost drivers for emergency, outpatient, and inpatient visits were laboratory and diagnostic fees, Western drug fees, and treatment and surgical fees, respectively. From 2018 to 2023, the ratio of psychiatry and general medicine visits increased, while annual direct medical costs for outpatient visits and tertiary hospital utilization declined. Age, gender, length of stay, hospital level, and comorbidity number were significantly associated with direct medical costs at the patient level.

Comparisons with previous studies

Healthcare resource utilization. Compared with previous studies conducted in high-income countries, the annual average of outpatient visits in this study was much lower, with a mean value of 2.42 times. In high-income countries, the mean visit time ranged from 7.3 to 22.68 per patient per year.[8–10] However, the number of emergency and inpatient visits was almost similar. Samples from UEBMI beneficiaries in another Chinese research reported slightly higher outpatient visits (2.9–3.1) and inpatient admissions (1.35).[12, 13] This phenomenon underlines the undertreatment for patients who sought medical service for MDD in China.

The difference in the distribution of medical visits was also observed. In high-income countries, the majority of mental healthcare resource utilization took place in primary care centers,[9, 32, 33] whereas the situation was inverse in China, showing an inverted triangle of medical visits and consistent with previous research.[12] This discrepancy reflects two systemic challenges: (1) limited mental health service capacity in China's primary care sector, and (2) underdeveloped referral mechanisms between healthcare tiers.

Regarding the treatment sectors, this study identified mental health specialty (Professional mental health treatments provided by specialists like psychiatrists, psychologists, or counselors in mental health centers or the department of psychiatry in secondary or tertiary hospitals) as the most frequently accessed sector, a finding in line with nationally representative survey data.[7] Notably, this pattern diverges significantly from that observed in high-income countries, where general practitioners in primary care centers serve as the main healthcare service providers.[9, 34]

Those disparities in healthcare resource utilization might be due to the heterogeneity in healthcare medical settings, data sources, and reimbursement mechanisms. Although the basic medical insurance in China covers nearly 94.6% of the population in 2023,[35] the relatively low reimbursement ratios and high deductible lines in outpatient visits might affect the health-seeking behaviors, especially for those with less severe depressive symptoms.[36, 37] Moreover, there were great discrepancies in different health insurance schemes, both in fund level and benefit package, which might lead to different healthcare resource utilization patterns.[38] Previous studies found that beneficiaries under the UEBMI scheme were more likely to use more health services.[39–41]

Direct medical costs. It was found that the average annual per-capita direct medical costs for emergency visits, outpatient visits, and inpatient visits were, respectively, 118.21 USD, 148.94 USD, and 2,289.54 USD. Notably, these cost estimates differ substantially from those reported in other countries. Specifically, the figures in this study were considerably lower than those in the United States (emergency: 1,081 USD; outpatient: 7,332 USD; inpatient: 4,551 USD; 2023 data)[14], while the estimations from Canada reported a lower direct medical costs for inpatient service (emergency: 124 USD; outpatient: 892 USD; inpatient: 1,064 USD; 2023 data).[15] Regarding the per-patient-per-year direct medical cost, the values in this study (262.9 USD) were also lower than estimates from Spain (1,088 USD in 2023),[16] Singapore (1,293 USD in 2023),[17] and Iran (1,730 USD in 2023).[18] This further confirms the undertreatment of MDD and the corresponding consequence (i.e., higher costs for hospitalization) in China.[12, 42] However, these cross-country comparisons should be interpreted with caution due to several limitations, including differences in study design, cost estimation methodologies, sample selection criteria, and healthcare system structures.

In contrast to prior studies conducted among Chinese UEBMI beneficiaries, this study reported lower average direct medical costs than those of Ding et al. (888.35 USD in 2023)[12] and Zhang et al.'s study (581.34 USD in 2023).[13] Several factors may explain this discrepancy. First, the UEBMI program's comprehensive benefit package, higher reimbursement rates, and broader service coverage likely facilitate more adequate treatment access.[38] Additionally, as UEBMI primarily covers employed individuals with stable incomes and stronger financial capacity, beneficiaries may be more proactive in seeking timely medical care when needed.[43]

Concerning the costs composition, the structures differed across healthcare services, with emergency visits dominated by laboratory and diagnostic fees, outpatient visits by Western medication costs, and inpatient visits by treatment and surgical expenditures. This was consistent with the finding of a previous study, with medication and medical service costs being the major contributors to depression-related medical costs and the proportion of medical service costs increasing with the severity of depression.[12] According to the treatment guidelines of MDD, patients with mild to moderate symptoms were recommended to be treated with antidepressants, and patients with severe symptoms with combined therapy including psychotherapy, pharmacotherapy, and other therapies (e.g., electroconvulsive therapy).[44–46] It was reported that severe MDD cases used more hospitalization services.[12]

Temporal trend. Between 2018 and 2023, significant shifts occurred in mental healthcare utilization patterns and direct medical costs. Increasing trends were observed in mental health specialty visits and general practice visits, while declining trends were noted in tertiary hospital visit proportions and costs for outpatient service. The changes of proportions in treatment sectors and hospital levels could be partially attributed to the implementation of integrated mental health care models connecting primary, hospital, and community care divisions in Nanshan District, Shenzhen City.[47] Patients who were suspected to have depression by general practitioners were screened in the primary healthcare centers first, and then those with positive screening results were provided with a referral gateway between primary health care centers and general and specialized mental health hospitals. Regarding the decline trend of direct medical costs of outpatient costs, one possible explanation was the effect of the national volume-based procurement policy in China in 2019, which aims to lower drug prices and enhance pharmaceutical affordability, including the first-line antidepressants.[48, 49]

Factors associated with direct medical costs. It was found that age, gender, length of stay, hospital level, and comorbidity number were significantly associated with direct medical costs at the patient level. Age was positively associated with direct medical costs, and MDD patients with higher age tend to have higher costs. It was suggested that patients of older age were significantly associated with a worse 2-year MDD course, resulting in higher direct medical costs.[50] Compared to female patients, male patients incurred higher direct medical costs, which were in line with the findings in a previous study.[12] One plausible explanation might be that male patients demonstrate lower mental healthcare utilization than their female counterparts during early disease stages, typically seeking treatment only after symptom severity has significantly progressed. Thus, more intensive and advanced therapies were required when using healthcare resources, and the higher direct medical costs were incurred. Patients who were admitted to tertiary hospitals had a higher value of direct medical costs, and this finding aligns well with other studies.[12] It was thought that patients who sought healthcare services in tertiary hospitals tend to have better financial conditions, more severe conditions, and require more treatments.[51, 52] A similar explanation could be employed in the length of stay, which, to some extent, represented the severity of cases. The mean length of stay was 0.72 days overall, much lower than the figures in Lundberg et al. (2.60 days)[9] and Zhdanava et al.'s study (1.33 days).[8] This further indicates the undertreatment of MDD in China. Patients with comorbid conditions incurred higher direct medical costs, which could be attributed to the increased medical expenses associated with these additional conditions.

Policy implications. This study provided an updated and comprehensive description of healthcare resource utilization patterns, direct medical costs, and the corresponding temporal trend for patients with MDD in China, which revealed critical gaps in China's depression care system that demand multi-level interventions. First of all, the phenomenon of undertreatment in treated MDD cases necessitates nationwide mental health literacy campaigns and clinician training to improve detection and treatment adherence, particularly in primary care settings. Moreover, it also suggests offering certain preferential policies to guide demand for healthcare services and enhance the accessibility of healthcare services, such as extending the list of more antidepressants into the volume-based procurement policy and incorporating evidence-based treatments into insurance reimbursement schemes. Secondly, although the declining

temporal trend of the proportion of tertiary hospitals utilization indicates the effect of established integrated care of mental health in the Nanshan District, the consistent overutilization underscores the urgent need to further strengthen primary mental healthcare, consolidate the established integrated model of mental health, and improve referral channels. Thirdly, the substantial direct medical costs for emergency and inpatient services and the associated factors with direct medical costs highlight the importance of preventive strategies, including regional depression registries for proactive follow-up and community-based early intervention programs.

Limitations. Several important limitations should be considered when interpreting the findings in this study. First, the generalizability of our results to China's broader depressed population may be limited, as our database exclusively comprised urban residents, potentially overlooking important rural-urban disparities in healthcare utilization patterns. Second, the absence of key socioeconomic indicators (e.g., education level, household income, and occupational status) in our dataset prevented adjustment for these potential confounders, which may influence the healthcare utilization patterns and cost. Third, due to data constraints, the cost analysis was restricted to direct medical costs, thereby excluding the direct non-medical costs and indirect costs that constitute a major component of the economic burden. Future studies should incorporate both urban and rural populations to better characterize geographic disparities in depression care patterns and costs. Research would also benefit from datasets that include detailed socioeconomic variables to enable the identification of vulnerable populations requiring targeted interventions. Moreover, a more comprehensive estimation of the economic burden of MDD could be achieved by including all types of costs (i.e., direct medical costs, direct non-medical costs, and indirect costs). Despite the above-mentioned limitations, this study offers the most up-to-date and comprehensive analysis of healthcare utilization patterns and direct medical costs among urban MDD patients in China, filling a critical evidence gap for mental health policy formulation during a period of rapid healthcare system reform.

Conclusion

This study confirms the undertreatment of MDD in urban China, especially in the outpatient services. From the perspective of the healthcare system, MDD imposes significant economic burdens for admitted patients, with tertiary hospitals serving as the primary providers of depression-related services. The temporal trends of healthcare resource utilization patterns and costs indicate the efficacy of integrated care of mental health in the Nanshan District. It was identified that age, gender, hospital levels, length of stay, and comorbidity number were key determinants of direct medical costs. These findings highlight the urgent need for policy interventions to (1) enhance mental health training for multi-tier hospitals, especially primary and secondary care settings and optimizing the existing dual referral systems, (2) strengthen the outpatient reimbursement policy and (3) implement effective prevention programs and timely critical care interventions to decrease the utilization of emergency and hospitalization.

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethical Review Committee of Shenzhen Nanshan Center for Chronic Disease Control (Approval No. LL20210038). This study involved the secondary analysis of de-identified electronic medical record data and did not involve direct contact with patients. Individual informed consent was not obtained because the analysis was based exclusively on de-identified routinely collected healthcare data. All methods were performed in accordance with the Declaration of Helsinki and relevant guidelines and regulations.

Consent for publication

Not Applicable. All data used in this study analysis were de-identified. This study did not involve the collection of personal or clinical details from participants, nor does it present identifying images or data.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

JH, Y Liao, and Y Liu had full access to all of the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. Concept and design were contributed by JH and WZ. Data acquisition, analysis, or interpretation were performed by all authors. JH and WZ drafted the manuscript. Statistical analysis was performed by JH and WZ. Funding was obtained by CL and WW. Supervision was provided by LG, XH and CL. All authors critically reviewed the manuscript for important intellectual content and granted final approval for submission.

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Data Availability

The datasets used in the current study are available from the corresponding author on reasonable request.

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Figures

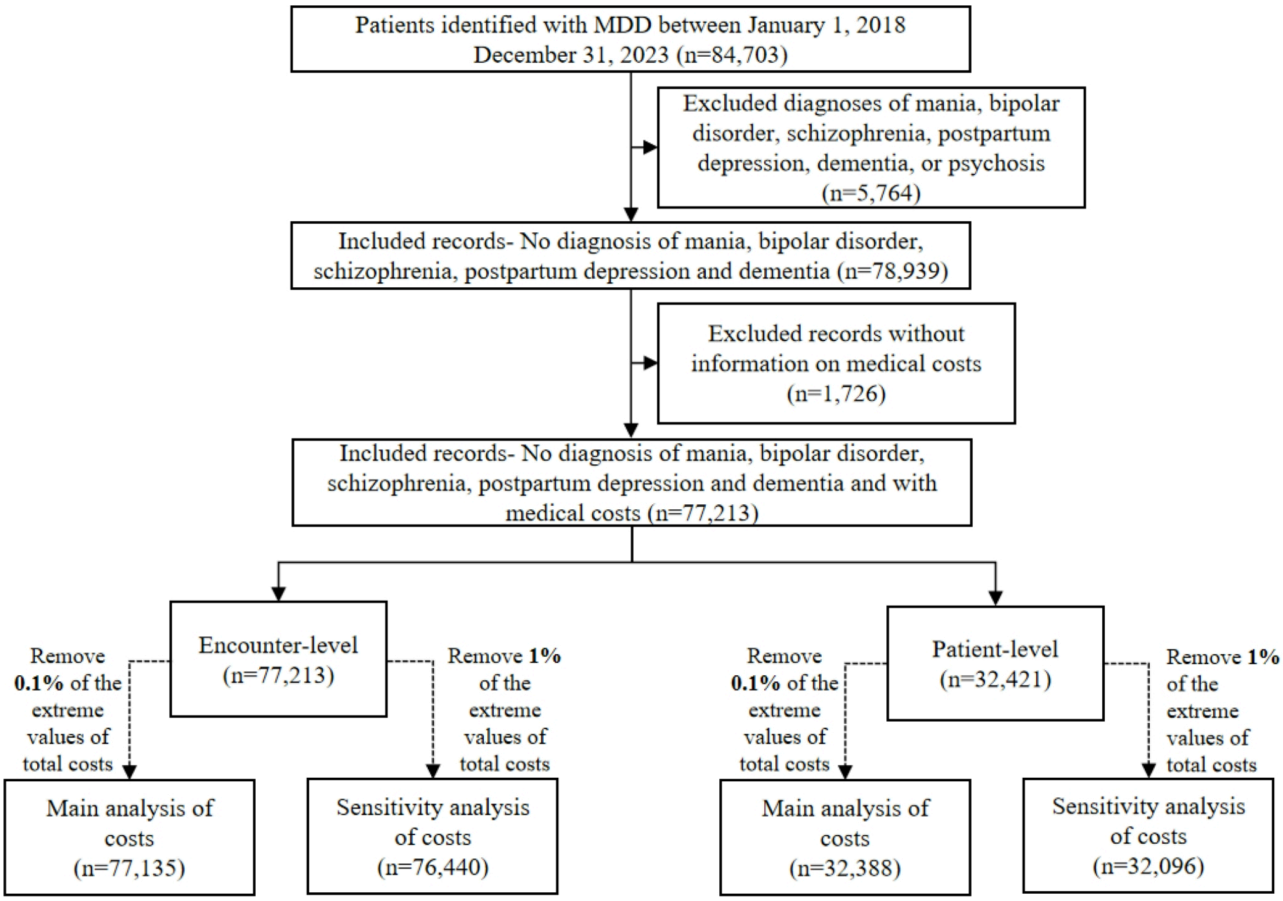


Figure 1

Sample selection flow chart

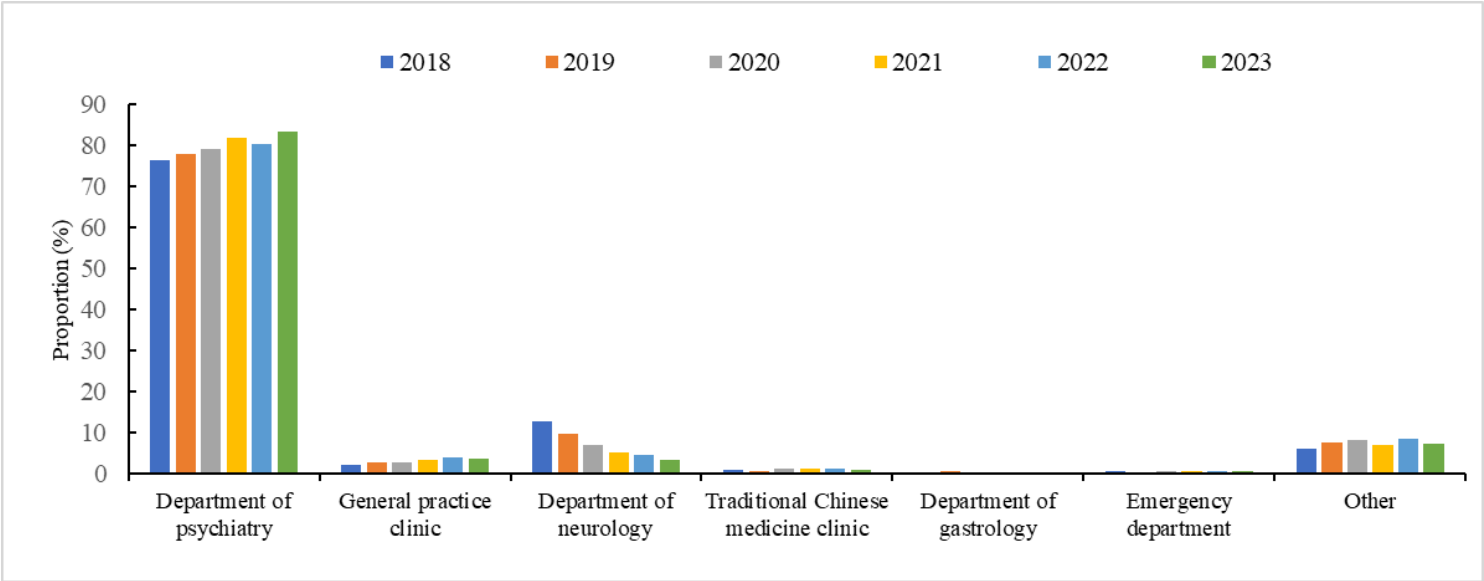


Figure 2

The distribution of departments of healthcare utilization and the time trend

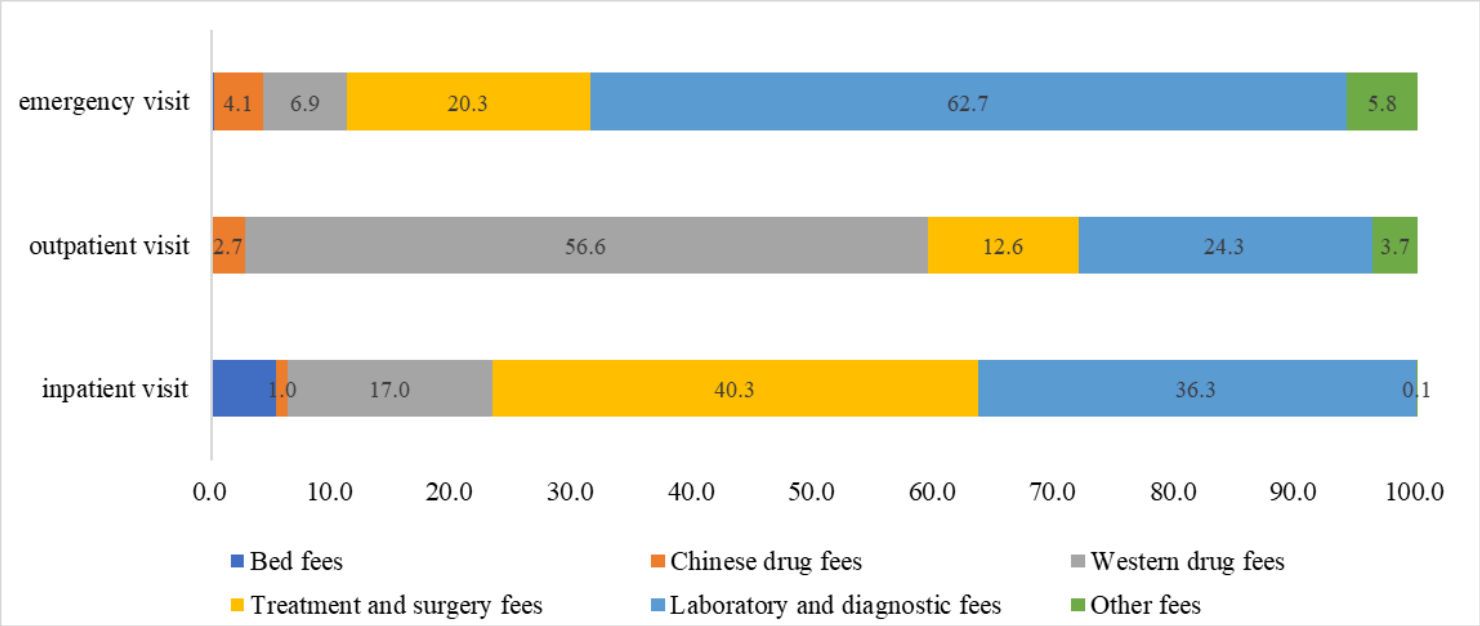


Figure 3

The composition of direct medical costs by healthcare utilization type