



Prevalence and Economic Burden of Mental Illness Among Middle-Aged and Older Adults in China: The Role of Artificial Intelligence in Predicting Healthcare Burden

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Abstract. China's middle-aged and elderly people have a high prevalence of mental illness and a heavy financial burden. According to the study, between 2011 and 2018, the average annual medical costs of patients with mental illness rose sharply, and the proportion of out-of-pocket payments for rural patients declined but was still higher than that of urban areas. Artificial intelligence plays a significant role in predicting diseases and optimizing resource allocation. Promoting home-based intelligent robot-assisted treatment can reduce care costs and improve treatment efficiency. Meanwhile, the AI disease co-management model is expected to further reduce the medical burden of patients with mental illnesses through whole-life health management.

Keywords: Mental Illness; Economic Burden; AI; Middle-aged and Older Adults

1 Introduction

Mental health issues have emerged as a significant public health concern globally, particularly among middle-aged and older adults. In China, with its rapidly aging population, the prevalence of mental illness among this demographic has reached alarming proportions. Over 100 million people in China suffer from mental disorders, posing a substantial economic burden on individuals, families, and society as a whole.

In this context, artificial intelligence (AI) has shown great promise in revolutionizing healthcare delivery, particularly in the field of mental health. By leveraging advanced analysis and machine learning algorithms, AI can predict disease progression, optimize resource allocation, and provide personalized treatment plans, thereby potentially reducing the economic burden of mental illness. This study aims to explore the prevalence and economic burden of mental illness among middle-aged and older adults in China and evaluate the potential role of AI in mitigating this burden. Utilizing data from

CHARLS, we analyze the prevalence of mental illness in different age groups, genders, and regions, as well as the associated economic costs. Furthermore, we discuss the implications of AI in mental healthcare, including its potential to improve disease prediction, resource management, and patient outcomes.

2 Research Background

2.1 Prevalence of Mental Illness Among Middle-Aged and Older Adults in China

According to the World Mental Health Report published by the World Health Organization (WHO) in 2022, nearly one billion people worldwide suffer from mental illness, including approximately 60 million with bipolar disorder and 23 million with schizophrenia. Data from the Mental Health Center of the Chinese Center for Disease Control and Prevention (CDC) indicate that over 100 million people in China are affected by mental disorders. With the deepening of population aging in China, the prevalence of mental illnesses among the older adults is increasing. For example, Alzheimer's disease (AD) and other dementias have a relatively high prevalence in China, with women experiencing nearly twice the incidence and mortality rates compared to men. According to GBD data, from the perspective of death attribution, the death attribution of people over 70 years old caused by neurological diseases has been higher than that of diabetes, digestive system diseases and other chronic diseases. The proportion of deaths caused by neurological diseases has risen from fourth place in 1990 to second place in 2021, behind cardiovascular disease, cancer and chronic respiratory diseases. From 1990 to 2019, deaths from Alzheimer's disease and other dementias, lung cancer, diabetes, and chronic kidney disease increased among people aged 70 years or older. From the perspective of disability-adjusted life years, neurodegenerative diseases such as Parkinson's disease, Alzheimer's disease and headache disease have become significant diseases affecting the length of life years. On a country scale, the impact of mental illness on disability-adjusted life years ranks fourth among diseases in China, far higher than in other countries in the world.

2.2 Burden Caused by Mental Illnesses

Patients with mental illnesses require long-term medical and pharmaceutical treatment, imposing significant economic pressure on both the patients and their families (PALLI, ALEXANDRA, et al. 2021)^[1]. For instance, the treatment costs for Alzheimer's disease are exorbitant, encompassing medication expenses, hospitalization fees, and continuous monitoring costs (SOETEMAN DI, et al. 2008)^[2]. Patients with mental illnesses often struggle to work and live normally, resulting in decreased productivity and reduced employment opportunities, further exacerbating the economic burden on society. Family members caring for patients with mental illnesses may face issues such as reduced income and job disruptions, while also having to bear the daily care costs of the patients. Mental illnesses not only impose economic burdens on patients and their families but also strain social resources (SOMNATH PAL, 2015)^[3]. Medical resources need to be

allocated towards patients with mental illnesses, and the social security system must provide more support for this group. Additionally, mental illnesses can trigger other social problems, such as family conflicts and social instability.

2.3 The Role of Artificial Intelligence in Healthcare Services

First, AI is able to process and analyze a large amount of health data (ANTAO, et al. 2023)^[4], including electronic health records, genomic data, imaging information and real-time biomarkers through big data analytics, and through machine learning algorithms, it can identify and predict patients' future risk factors and the pattern of disease progression, provide early warnings for patients and doctors, and monitor patients' vital signs and changes in their conditions at any time and predict the risk of deterioration of their conditions and thus effectively reduce the risk of accidental death of patients (PRADUMN SAXENA, SANDEEP PRABHU, 2023)^[5]. Secondly, through data analysis, the intelligent system can predict patients' demand for medical treatment (MARINA JOHNSON, et al. 2023)^[6], further rationalize the allocation of medical resources, and improve the efficiency of medical services, which also helps to alleviate the problem of strained medical resources.

2.4 Existing Interventions of Mental Health of Middle-Aged and Elderly Patients with Mental Illness

For middle-aged and elderly patients with mental illness, medication is one of the commonly used interventions, however, medication may have certain side effects and risks, so psychotherapy is also a necessary measure to improve the mental health of middle-aged and elderly patients with mental illness. On the one hand, cognitive-behavioral therapy and supportive psychotherapy are used to help patients adjust their mindset and alleviate their emotional distress; on the other hand, the construction of social support networks in the dimensions of family, peers, and community is used to provide spiritual support for middle-aged and elderly patients with mental illness. The prevalence of mental illness and economic burden among middle-aged and elderly people.

3 Prevalence and Economic Burden of Mental Illness Among Middle-Aged and Older Adults

The data for this study were obtained from the China Health and Retirement Longitudinal Survey (CHARLS) database, managed by the National School of Development at Peking University. This study focuses on older adults from the CHARLS database diagnosed with mental illness, using the following inclusion criteria: diagnosis of a mental illness by a physician, experience of an episode of mental illness, or a most recent healthcare visit related to mental illness.

3.1 Data and Methods

The direct economic burden in this study is divided into three components: **Direct medical costs:** This includes expenses related to outpatient visits, hospitalizations, and medication purchases from pharmacies. **Direct non-medical costs:** These refer to costs incurred for transportation and accommodation during treatment, as well as the time and expenses required for family members to care for the patient. **Self-medication costs:** These are the expenses borne by patients for self-administered treatments. Only patients whose most recent healthcare visit was explicitly due to cardiovascular disease were included in the cost estimation process.

3.2 Definition of Variables

Direct Medical Costs: Annual direct medical costs for mental illness patients include outpatient and hospitalization expenses. Outpatient costs are calculated as: Recent visit cost $\times$ number of visits in past month $\times$ 12. Hospitalization costs follow: Recent hospitalization cost $\times$ number of hospitalizations in the past year. Both total and out-of-pocket expenses are considered in separate calculations. **Direct Non-medical Costs:** These include transportation, accommodation, food, and caregiver expenses for both outpatient visits and hospitalizations. Formulas: Outpatient transportation: One-way cost $\times$ 2 $\times$ number of visits in past month $\times$ 12. Hospitalization costs: Recent hospitalization-related costs $\times$ number of hospitalizations in the past year. **Self-medication Costs:** As the CHARLS survey does not specify mental illness-related self-medication, these costs are estimated using: Monthly self-medication expenses $\times$ 12 $\times$ (Cardiovascular patients / Total chronic condition patients). Data Analysis: All analyses were conducted using Stata 17.0, with a significance level of 0.05.

4 Research Results

4.1 Overview

The CHARLS survey successfully interviewed 17,705, 18,605, 21,095, and 19,816 participants in 2011, 2013, 2015, and 2018, respectively. Among these participants, the number of middle-aged and older adults (aged 45 and above) diagnosed with mental illness was 242 individuals (1.41%) in 2011, 272 individuals (1.53%) in 2013, 225 individuals (1.58%) in 2015, and 223 individuals (1.18%) in 2018. In general, the prevalence of mental illness increased with age ($P < 0.05$), with individuals aged 60–74 identified as the most affected group. Across all survey years, the prevalence of mental illness among women was consistently higher than among men ($P < 0.05$). Additionally, in 2011, 2013, and 2015, the prevalence of mental illness among middle-aged and older adults in rural areas was significantly higher than that in urban, as shown in Tables 1–2. However, in 2018, the prevalence rate in rural areas fell below that of urban areas.

Table 1. Prevalence of Mental Illness in Urban and Rural Areas (2011 & 2013)

	2011						2013					
	Urban		Rural		Total		Urban		Rural		Total	
	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	frequency	prevalence rate (%)	frequency	prevalence rate (%)
Age												
Group												
45-59	25	1.27	91	1.24	116	1.25	28	1.4	98	1.41	126	1.4
60-74	19	1.35	81	1.8	100	1.69	16	0.99	105	2.04	121	1.79
75+	6	1.56	14	1.22	20	1.31	6	1.27	16	1.25	22	1.25
Gender												
Male	26	1.32	68	1.09	94	1.15	24	1.12	73	1.15	97	1.14
Female	25	1.34	123	1.74	148	1.66	27	1.35	148	2.02	175	1.88
Region												
Eastern	20	1.57	51	1.08	71	1.18	12	0.88	61	1.25	73	1.17
Central	26	1.33	90	1.73	116	1.62	33	1.61	102	1.9	135	1.82
Western	5	0.83	50	1.49	55	1.39	6	0.84	58	1.68	64	1.53
Total	51	1.33	191	1.44	242	1.41	51	1.23	221	1.61	272	1.53

Table 2. Prevalence of Mental Illness in Urban and Rural Areas (2015 & 2018)

	2015						2018					
	Urban		Rural		Total		Urban		Rural		Total	
	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)	fre- quency	prevalence rate (%)
Age												
Group												
45-59	18	1.52	62	1.21	80	1.27	19	1.25	58	0.9	77	0.97
60-74	17	1.36	104	2.1	121	1.95	25	1.46	82	1.27	107	1.31
75+	7	1.77	16	1.37	23	1.47	10	1.58	28	1.39	38	1.44
Gender												
Male	18	1.21	56	1.06	74	1.1	13	0.65	57	0.83	70	0.79
Female	24	1.76	127	1.06	151	2.03	41	2.15	112	1.38	153	1.52
Region												
Eastern	9	0.95	48	1.19	57	1.15	16	1.37	43	0.81	59	0.91
Central	28	2.03	85	1.93	113	1.96	23	1.16	69	1.18	92	1.17
Western	5	0.94	50	1.71	55	1.59	15	2.01	57	1.48	72	1.56
Total	42	1.47	183	1.61	225	1.58	54	1.38	169	1.12	223	1.18

4.2 Calculation of the Economic Burden of Mental Illness

The economic burden of mental illness is assessed by calculating both direct medical costs and non-medical costs, as well as self-medication expenses. Direct medical costs

include expenditures on outpatient visits, hospitalizations, and medications, while non-medical costs encompass transportation, accommodation, and caregiving expenses incurred during treatment.

The calculation of direct non-medical costs involves adding transportation costs for outpatient visits and hospitalization-related expenses, such as accommodation, meals, and caregiver wages. For outpatient visits, transportation costs are estimated by multiplying the one-way transportation cost by two (for a round trip), then by the number of visits in the past month, and finally by 12. Hospitalization-related costs are calculated by multiplying the relevant expenses from the most recent hospitalization by the total number of hospitalizations over the past year. Due to limitations in the CHARLS survey design, it is not possible to determine whether self-medication expenses are directly related to mental illness. Therefore, the self-medication costs are estimated using the following formula: monthly self-medication expenses multiplied by 12, adjusted by the proportion of cardiovascular patients among all chronic condition patients. All statistical analyses were conducted using Stata 17.0, with a significance level set at 0.05(see Table 3).

A comparison of healthcare costs by service type reveals that, after reimbursement, the annual outpatient costs for mental illness patients in 2011, 2013, and 2015 were higher than the annual hospitalization costs. However, in 2018, hospitalization costs surpassed outpatient costs, primarily due to a sharp increase in hospitalization expenses for rural mental health patients. Between 2011 and 2018, both direct medical costs (outpatient and hospitalization) and direct non-medical costs showed an upward trend for both urban and rural patients, with the most significant increase occurring between 2015 and 2018 (see Table 4).

Table 3. Medical Reimbursement Statistics for Urban and Rural Residents (2011-2018)

	2011			2013			2015			2018		
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Direct Medical costs												
Before	11869.18	3616.68	5355.84	1942.59	7492.15	6451.61	4573.14	8171.81	7500.06	11116.41	61999.46	49678.00
After	6069.18	3142.17	3759.02	1595.14	5606.64	4854.48	5358.86	6458.85	6253.52	6753.15	30169.12	24498.88
Self-Medication Costs												
Before	2333.62	1543.53	1706.40	3308.47	1439.29	1789.77	3068.57	2942.33	2965.89	7162.33	3890.43	4660.29
After	2052.47	1397.50	1535.53	3313.18	1439.29	1790.65	3240.00	2455.64	2602.05	6783.43	3778.11	4474.71
Non-Medical Costs												
Before	—	—	—	9.45	1001.90	815.82	233.62	639.84	564.01	—	—	—
After	14283.67	5356.33	7237.71	5260.51	9933.34	9057.19	7875.33	11753.98	11029.96	15891.30	64692.83	52875.42
After	8385.55	4816.60	5568.73	4917.77	8047.83	7460.94	8832.48	9554.32	9419.58	11149.81	32762.37	27528.84
Out-of-Pocket Ratio(%)	58.71%	89.92%	76.94%	93.48%	81.02%	82.38%	112.15%	81.29%	85.40%	70.16%	50.64%	52.06%

*Before: Before Reimbursement; After: After Reimbursement

Table 4. Medical Reimbursement Statistics by Healthcare Type for Urban and Rural Residents

		2011			2013			2015			2018		
		Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total
Direct Medical Expenses (Before)							25869.2	21544.7	15759.0	24024.2	22776.6	12189.1	
	Outpatient	43865.33	9504.72	14746.17	6264.80	8	6	0	7	8	8	22410.50	19737.23
	Inpatient	21054.00	6953.23	10392.44	1700.00	7694.41	7244.83	11000.0	14798.2	14127.9	18717.6	164951.0	125580.4
Direct Medical Expenses (After)							19497.5	16591.3	28124.5	20846.3	21807.6	8505.88	13360.24
	Outpatient	24932.00	8805.50	11351.79	5589.43	1	4	7	5	2			
	Inpatient	8514.00	5725.48	6405.61	775.00	5413.13	4971.41	4700.00	8260.63	7613.24	10003.18	76158.77	57965.99
Direct non-medical expenses	Outpatient	451.20	399.43	407.27	61.71	5454.99	4556.11	789.00	2243.08	1900.94	—	—	—
	Inpatient	1018.46	1303.44	1230.54	16.67	952.97	872.71	583.33	2350.80	2008.71	—	—	—

- 5Discussion and Conclusion
- 5.1The Heavy Economic Burden of Mental Illness and Declining Out-of-Pocket Ratios for Rural Patients
- 5.2The AI Co-Management Model is Beneficial in Narrowing the Gap in Mental Health Burdens between Urban and Rural Areas

The study reveals that the economic burden of mental illness among middle-aged and elderly patients in China is significant, with the average annual out-of-pocket burden reaching 27,528.84 CNY per person in 2018, a substantial increase compared to 2011. Although rural patients received higher reimbursements than their urban counterparts, the out-of-pocket ratio for rural residents decreased to 50.64% in 2018, marking a significant decline from previous years.

The findings show that there is an imbalance in medical resource allocation between urban and rural areas, and most of the economic burden of disease is transferred to individuals. Rural patients need to spend more on transportation and accommodation costs to access medical services, they also face a higher risk of catastrophic health expenditures.

Under the AI model, residents' medical burdens will be effectively reduced and the urban-rural gap will be further narrowed. Take the medical reform pioneer city of Sanming, Fujian Province as an example. In 2024, when the "AI six-disease management" model is established and further implemented, it will be based on a comprehensive and lifecycle medical treatment system that covers the entire process of "prevention, screening, diagnosis, treatment, management, and rehabilitation" and a multidisciplinary treatment model. This will enable many chronic diseases to be detected, treated, controlled, and prevented in a timely manner, thereby significantly reducing the disease

burden and economic burden brought about by chronic diseases. Accordingly, it is predicted that the medical burden of rural mental illness patients in China will also be effectively reduced.

5.3 The Role of Home Robots in Supporting Self-Care for Mental Illness Patients

Given the preference among elderly patients for self-care at home, the use of AI-powered home robots offers a promising solution. These robots can provide essential emotional support by recognizing patient emotions through voice and facial expressions, mimicking human responses to offer a sense of security and comfort (SALIH TUTUN, et al. 2022)^[7]. Such emotional support helps alleviate loneliness and anxiety, improving patients' quality of life. Additionally, these robots can help in memory exercises and social skill development, that is useful in promoting cognitive function and social adaptation.

AI psychological service robots also offer standardized assessments and psychological interventions, enhancing self-referral rates and reducing the stigma associated with seeking help from humans. The economic benefits of home robots are evident—they lower long-term care costs, improve treatment efficiency and outcomes, foster patient autonomy, reduce healthcare resource waste, and enhance the quality of life for patients and their families. As AI and robotics technologies continue to advance, the role of home robots in mental health care will become increasingly significant, providing essential support for self-care.

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