Preplanned Studies

Estimating Hospitalization Expenditures Associated with Chronic Diseases and Multimorbidity for Older Adults — Guangzhou City, Guangdong Province, China, 2017–2019

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Summary

What is already known about this topic?

Chronic diseases and multimorbidity impose substantial burdens on healthcare systems globally, particularly in aging populations, resulting in elevated healthcare utilization rates and increased expenditures.

What is added by this report?

This study validates previous research findings using an extensive administrative database from a major city in South China. Additionally, it provides comprehensive estimates of annual hospitalization expenditures per patient associated with chronic diseases and multimorbidity patterns among older adults, elucidating the economic burden and cost variations across specific diseases and multimorbidity combinations. Cancer, cerebrovascular disease (CVD), and heart disease — whether occurring individually or in conjunction with other chronic conditions, particularly within complex multimorbidity patterns — were associated with substantial annual hospitalization expenditures and significant healthcare resource utilization.

What are the implications for public health practice?

Disease burden studies provide critical evidence for prioritizing public health policies and targeted interventions. Policymakers should implement comprehensive prevention strategies, evidence-based interventions, appropriate reimbursement policies, and integrated management approaches to control disease progression and reduce healthcare expenditures.

ABSTRACT

Introduction: Chronic diseases and multimorbidity are increasingly prevalent among older adults in China, contributing substantially to hospitalization burden. However, real-world evidence on their direct medical expenditures remains limited.

Methods: This study employed a retrospective analysis by using hospital discharge data from Guangzhou during 2017–2019, and adopted generalized linear models (GLMs) to estimate hospitalization expenditures across chronic disease and multimorbidity patterns.

Results: Older patients with multimorbidity incurred nearly double the median annual hospitalization expenditures (3,708 USD *vs.* 1,844 USD) and 45% higher costs per additional condition compared to single diseases. Hospitalization cost varied by specific diseases and multimorbidity patterns. Schizophrenia (7,421.3 USD) has the highest annual total hospitalization expenditure (THE) among single chronic diseases while the combination of cancer + CVD + heart disease (10,698.8 USD for THE, 4,024.6 USD for out-of-pocket expenditure) ranked the top expenditures among multimorbidity patterns. Approximately 57.1% of disease combinations exhibited super-additive spending.

Conclusion: This study provides robust evidence of the substantial economic burden of chronic diseases and multimorbidity. The findings underscore the need for an integrated care model, evidence-based strategies to optimize healthcare resource allocation and health outcomes in aging populations.

Chronic diseases have emerged as major public health challenges in China, with their prevalence and incidence rates increasing rapidly over the past two decades. Multimorbidity, defined as the co-occurrence of two or more chronic diseases, results in poorer health-related quality of life and higher health service utilization and expenditures compared to single

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conditions (*1*–*3*). In China, multimorbidity prevalence exhibits a marked age gradient, ranging from 30.2% (aged 50–54 years) to 57.5% (aged 80–84 years), with corresponding mortality rates of 15.92–24.80 per 1,000 person-years among those ≥65 years (*1*–*2*). Multimorbid patients constitute 72.7% of outpatient and 77.3% of inpatient services among adults aged ≥50 years, with their annual hospitalization costs varying between physical [3,703.2 Chinese Yuan (CNY)] and physical-mental (5,969.5 CNY) multimorbidity patterns, underscoring their substantial healthcare burden (*3*). Understanding expenditures related to chronic multimorbidity among older adults is therefore crucial for informed decision-making. This study examines the impact of specific chronic diseases and multimorbidity patterns on hospitalization spending by comparing sociodemographic characteristics, annual hospitalization healthcare resource utilizations (HCRUs), and costs between older patients with single chronic conditions and those with multimorbidity using real-world hospital discharge data. Key findings reveal that schizophrenia imposes a substantial economic burden on both payers and families. Cancer, cerebrovascular disease (CVD), and heart disease — whether occurring alone or within complex multimorbidity patterns — are also associated with high annual hospitalization expenditures and significant resource utilization. This knowledge is essential for guiding resource allocation, designing cost-effective prevention and intervention strategies, and ultimately reducing socioeconomic burden while improving quality of life and enhancing population health outcomes.

Despite numerous studies exploring the association between multimorbidity and healthcare costs, a significant gap remains in understanding the economic burden of multimorbidity in China. Existing research typically focuses on a limited range of chronic conditions, employs overly simplistic definitions of multimorbidity, and frequently relies on self-reported data, resulting in biased and inconsistent estimates. This study adopts a comprehensive approach to accurately assess this burden, providing robust evidence for public policy and practice. It employed a retrospective cohort design using a de-identified hospital discharge database from 273 public hospitals and medical institutions in Guangzhou (2017–2019). Patients aged 50 years or older with 1 or more of 40 predefined chronic conditions (Supplementary Table S1, available at https://weekly.chinacdc.cn/) were categorized into single disease or multimorbidity cohorts based on the number of unique chronic conditions for which they were hospitalized as the primary diagnosis. This study then excluded hospitalization records for non-targeted conditions to maintain data accuracy and relevance. Descriptive analyses were conducted to characterize patient demographics, HCRUs, and expenditures across cohorts and by specific chronic diseases and multimorbidity patterns. This study also used generalized linear models (GLMs) with gamma distribution and log-link function to examine the correlation between multimorbidity and annual hospitalization spending, as well as to estimate the impact on annual total hospitalization expenditures (THE) and annual hospitalization out-of-pocket expenditures (OOPE) associated with specific chronic diseases and multimorbidity patterns. GLM accounts for the skewed distribution of cost data. All analyses were conducted in SAS (version 9.4, SAS Institute Inc., Cary, NC, USA).

After applying sample inclusion and exclusion criteria (Supplementary Figure S1, available at https://weekly.chinacdc.cn/), the overall cohort comprised 273,452 patients, with 159,847 (58.5%) having a single chronic condition and 113,605 (41.5%) experiencing multimorbidity. The mean age was 68.9 years, with multimorbidity patients being older (mean age 70.1 years) compared to those with a single chronic condition (mean age 68.1 years). Patients aged 65 or above and women demonstrated significantly higher rates of multimorbidity than their younger and male counterparts, respectively (P<0.0001). Multimorbidity patients averaged 2.03 (±1.83) inpatient visits and experienced longer hospital stays (mean 20.2±31.2 days) compared to those with a single chronic condition. The crude median annual THE and OOPE in the multimorbidity cohort were [3,708.1 United States Dollars (USD)] and 1,844.6 USD, respectively — nearly double those observed in patients with a single chronic condition. Overall, traditional Chinese medicine (TCM) expenditures accounted for approximately 15.8% of total medication expenses (Table 1).

The most prevalent chronic diseases among hospitalized patients were heart disease (9.7%), CVD (9.5%), and cancer (6.8%). Annual hospitalization duration varied substantially across conditions, ranging from 2.1 (±1.7) days for senile cataracts to 19.4 (±40.9) days for CVD. The most common multimorbidity patterns included CVD + heart disease

TABLE 1. Patient demographics, crude annual healthcare resource utilization, and costs of elderly hospitalized patients.

Variables	Overall (*N*=273,452)	Single condition (*N*=159,847)	Multimorbidity (*N*=113,605)	*P*
Age (at initial inpatient admission) [mean (SD)]	68.97 (11.34)	68.14 (11.70)	70.13 (10.71)	<0.0001
Age category (*n*, %)				
50–64	106,765 (39.04)	67,985 (42.53)	38,780 (34.14)	<0.0001
65–79	108,904 (39.83)	59,786 (37.40)	49,118 (43.24)	
≥80	57,783 (21.13)	32,076 (20.07)	25,707 (22.63)	
Gender (*n*, %)				
Male	128,536 (47.00)	77,148 (48.26)	51,388 (45.23)	<0.0001
Female	144,916 (53.00)	82,699 (51.74)	62,217 (54.77)	
Insurance type (*n*, %)				
UEBMI	179,635 (65.69)	107,869 (67.48)	71,766 (63.17)	<0.0001
URRBMI	93,817 (34.31)	51,978 (32.52)	41,839 (36.83)	
Follow-up period (*n*, %)				
1 year	107,613 (39.35)	94,470 (59.10)	13,143 (11.57)	<0.0001
2 years	95,803 (35.03)	48,757 (30.50)	47,046 (41.41)	
3 years	70,036 (25.61)	16,620 (10.40)	53,416 (47.02)	
Number of chronic conditions [mean (SD)]	1.23 (1.11)	1.00 (0)	2.64 (0.96)	<0.0001
Number of chronic conditions (category, *n*, %)				
2			67,245 (59.19)	
3			28,512 (25.10)	
≥4			17,848 (15.71)	
Inpatient healthcare utilization (PPPY)				
Inpatient visits [mean (SD)]	1.55 (1.57)	1.21 (1.26)	2.03 (1.83)	<0.0001
Days of hospitalization [mean (SD)]	16.05 (32.26)	13.10 (32.66)	20.21 (31.21)	<0.0001
Number of surgeries (*n*, %)				
No surgeries	171,487 (62.71)	114,139 (71.41)	57,348 (50.48)	<0.0001
1 surgery	51,360 (18.78)	21,175 (13.25)	30,185 (26.57)	
2 surgeries	23,506 (8.60)	10,638 (6.66)	12,868 (11.33)	
≥3 surgeries	27,099 (9.91)	13,895 (8.69)	13,204 (11.62)	
Inpatient cost (PPPY)				
Total hospitalization expenditures (median, IQR)	2,491.6 (4,323.1)	1,844.6 (3,003.4)	3,708.1 (5,324.4)	<0.0001
Cost=0 (*n*, %)	0 (0)	0 (0)	0 (0)	
Total medication expenditures (median, IQR)	632.7 (1,127.5)	436.3 (840.3)	951.7 (1,369.6)	<0.0001
Cost=0 (*n*, %)	398 (0.15)	398 (0.25)	0 (0)	
Total traditional Chinese medicine expenditures (median, IQR)	100.5 (250.8)	54.5 (187.7)	172.4 (297.3)	<0.0001
Cost=0 (*n*, %)	42,470 (15.53)	38,479 (24.07)	3,991 (3.51)	
Total hospitalization out-of-pocket expenditures (median, IQR)	675.1 (1,124.3)	529.1 (831.2)	947.8 (1,395.5)	<0.0001
Cost=0 (*n*, %)	39 (0.01)	37 (0.02)	2 (0)	
Total cost covered by basic medical insurance (median, IQR)	1,554.7 (2,702.5)	1,151.0 (1,946.2)	2,266.9 (3,386.4)	<0.0001
Cost=0 (*n*, %)	193 (0.07)	193 (0.12)	0 (0)	

Note: Age refers to the patient's age at their first inpatient visit during 2017–2019; Follow-up years are defined as the number of unique calendar years in which patients received at least one hospitalization for any reason in a given year; PPPY: Per person per year is calculated by dividing each patient's total inpatient health utilizations/costs from 2017 to 2019 by their follow-up years, then averaging these totals by the number of patients; All costs were adjusted for inflation to the year 2019 CNY using the national CPI and converted to 2019 USD at an exchange rate of 1 CNY=0.1449 USD. "Cost=0" in this table indicates the No. of patients with zero expenditures.

Abbreviation: SD=standard deviation; IQR=interquartile range; PPPY=per patient per year; CNY=Chinese yuan; USD=United States dollar; CPI=Consumer price index; UEBMI=Urban employee basic medical insurance; URRBMI=Urban resident basic medical insurance.

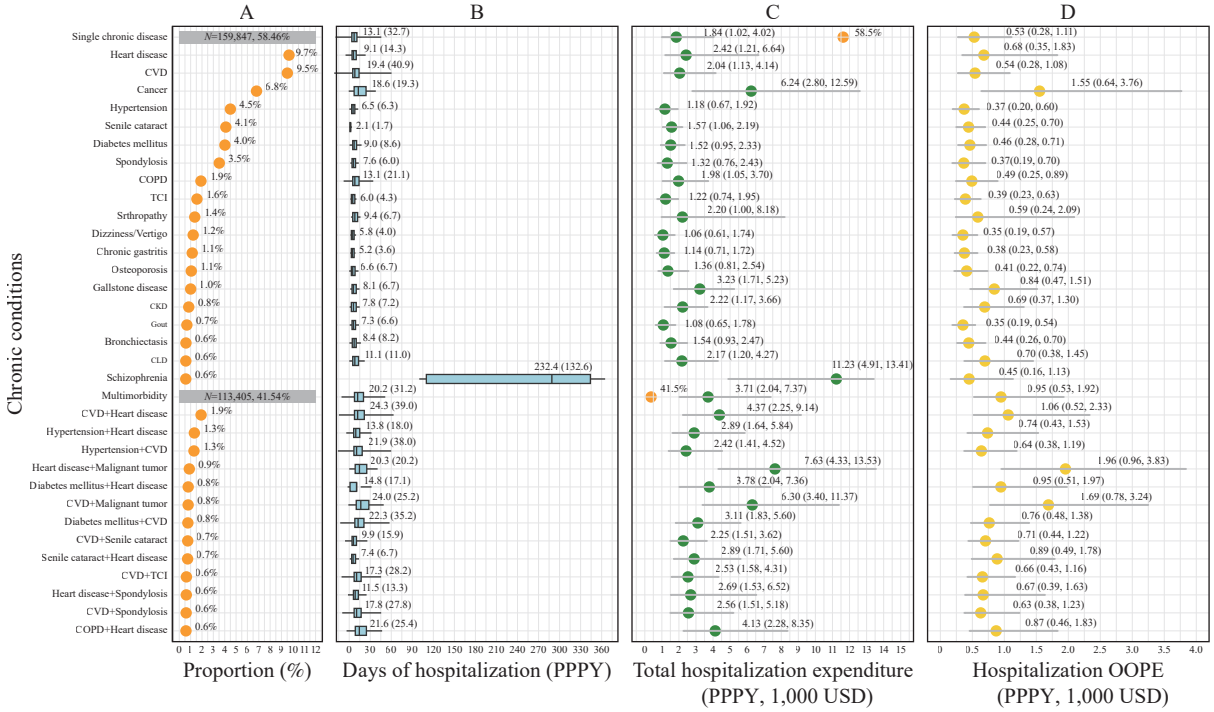

FIGURE 1. Descriptive statistics (PPPY) by specific diseases and multimorbidity patterns (ordered by proportion of hospitalized patient). (A) Proportion of patients hospitalized due to diseases; (B) Annual days of hospitalization; (C) Annua Total hospitalization expenditure (Crude); (D) Annual hospitalization Out-of-Pocket expenditure (Crude).
Note: Only chronic diseases and multimorbidity patterns with a patient proportion hospitalized during 2017–2019 greater than 500 per 100,000 are presented. Mean (SD) is shown for annual days of hospitalization; median (Q1, Q3) is shown for annual total hospitalization expenditure and annual hospitalization OOPE.
Abbreviation: PPPY=per patient per year; OOPE=out-of-pocket expenditure; SD=standard deviation; CVD=cerebrovascular disease; COPD=chronic obstructive pulmonary disease; TCI=transient cerebral ischemia; USD=United States dollar.

(1.9%), hypertension + heart disease (1.3%), and hypertension + CVD (1.3%), with cancer-based multimorbidity combinations resulting in the longest hospital stays and highest associated costs (Figure 1).

GLM analyses revealed that each additional chronic condition increased annual THE and OOPE by approximately 20%. Patients with two conditions experienced a 29% increase in THE and 28% increase in OOPE; those with three conditions showed a 54% increase in THE and 52% increase in OOPE; patients with four or more conditions demonstrated a 97% increase in THE and 87% increase in OOPE. Overall, multimorbidity was associated with 45% higher THE and 43% higher OOPE compared to single chronic conditions (Table 2).

Among single chronic diseases, schizophrenia demonstrated the highest estimated annual THE at 7,421.3 USD per patient per year (PPPY), followed by cancer at 5,751.6 USD, spleen disease at 4,405.8 USD, and arthropathy at 4,216.2 USD. For multimorbidity patterns, the combination of CVD + heart disease + cancer resulted in the most substantial costs, with an estimated annual THE of 10,698.8 USD and OOPE of 4,024.6 USD per patient. Other high-cost multimorbidity patterns included cancer-based dyads combined with arthropathy, chronic liver disease, anemia, heart disease, chronic obstructive pulmonary disease (COPD), and spondylosis, which generated annual THE ranging from 5,000 USD to 7,000 USD PPPY (Supplementary Figure S2, available at https://weekly.chinacdc.cn/).

The analysis revealed significant cost variations across different chronic diseases and multimorbidity patterns. Approximately 57.1% of disease combinations exhibited super-additive spending effects (where combined costs exceeded the sum of individual disease costs), 10% demonstrated additive spending patterns (where combined costs approximated the sum of individual diseases), and 32.9% showed sub-additive spending effects (where combined costs fell below the sum of individual diseases). Notably, the three largest super-additive effects in annual THE occurred in combinations of CVD + dementia (+1,496.6 USD), CVD + heart disease + cancer (+1,013.2 USD), and heart

TABLE 2. The association of multimorbidity and hospitalization expenditures among older adults.

Cohort	Estimated total hospitalization costs (PPPY)				Estimated annual hospitalization OOPE (PPPY)			
	Exp. (coefficient)	Stderr	95% *CI* lower	95% *CI* upper	Exp. (coefficient)	Stderr	95% *CI* lower	95% *CI* upper
Model 1								
Intercept* (USD)	2,611.3	0.0045	2,588.4	2,634.4	673.1	0.0045	667.2	679.1
No. of chronic conditions (range from 1-11)	1.22	0.0016	1.22	1.23	1.21	0.0016	1.20	1.21
Model 2								
Intercept† (USD)	3,143.4	0.0039	3,119.2	3,167.8	797.7	0.0039	791.6	803.9
One condition (reference)	1.00		1.00	1.00	1.00		1.00	1.00
Multimorbidity	1.45	0.0032	1.44	1.46	1.43	0.0033	1.42	1.44
Model 3								
Intercept† (USD)	3,157.8	0.0048	3,133.7	3,182.1	800.5	0.0039	794.4	806.6
One condition (reference)	1.00		1.00	1.00	1.00		1.00	1.00
Two conditions	1.29	0.0038	1.28	1.29	1.28	0.0038	1.27	1.29
Three conditions	1.54	0.0053	1.53	1.56	1.52	0.0053	1.51	1.54
Four or more conditions	1.97	0.0066	1.95	2.00	1.87	0.0065	1.84	1.89

Abbreviation: PPPY=per patient per year; OOPE=out-of-pocket expenditure; No.=number; UEBMI=urban employee basic medical insurance; *CI*=confidence interval.
* Age=50, sex=female, insurance type=UEBMI.
† Age=50, sex=female, insurance type=UEBMI, with single chronic condition.

disease + diabetes mellitus (+980.3 USD). Conversely, cancer + heart disease (–2,394.2 USD), cancer + arthropathy (–2,323.3 USD), and cancer + CVD (–1,435.4 USD) demonstrated the most pronounced sub-additive effects on expenditures (Supplementary Figure S2).

DISCUSSION

This study provides a comprehensive analysis of hospitalization expenditures associated with chronic diseases and multimorbidity patterns among older adults in Guangzhou City, Guangdong Province, China. Its findings align with previous research demonstrating that elderly patients and women are more likely to develop multimorbidity. A US epidemiologic review showed that 67% of Medicare beneficiaries had multimorbidity, with higher prevalence in older age groups and among women. This pattern reflects the "male-female health-survival paradox," where women experience higher rates of chronic diseases but tend to live longer, while men are more prone to severe conditions such as cancer and ischemic heart disease (*4*). This study confirms the increased healthcare resource utilization and costs associated with multimorbidity, consistent with existing literature (*3*). Schizophrenia costs 7,421.3 USD PPPY in our study, similar to Zhong et al.'s estimate of 8,061 USD for long-action injectable and 6,822 USD for orally treated schizophrenia patients (*5*). While Chen et al. observed a 3.4-fold cost increase for multimorbid patients in Beijing, higher than our study's estimates (*6*). Zhao et al. reported lower annual per-capita inpatient costs attributable to heart disease, chronic lung disease, and stroke or cardiovascular disease (*7*). These discrepancies likely reflect methodological variations in population sampling, diseases, and cost definitions.

This study observes significant heterogeneity in hospitalization costs across different multimorbidity patterns, primarily driven by variations in physiological functions and corresponding treatment approaches. Our findings demonstrate that organ-related multimorbidity, particularly involving cancer, CVD, and heart disease, incurs substantially higher hospitalization expenditures compared to sensory-related conditions. These complex diseases require intensive, specialized medical resources and prolonged inpatient care, making them less amenable to outpatient or community-based management. In contrast, foundational chronic conditions like hypertension and diabetes show relatively lower hospitalization costs, reflecting the successful implementation of past health policies and resource investments in chronic disease management. However, our analyses reveal potentially inefficient healthcare

utilization patterns, with many chronic disease patients receiving primarily medication and nursing care during hospitalization, suggesting opportunities for more cost-effective outpatient management for multimorbidity.

An interesting finding is the super-additive effect observed in certain multimorbidity patterns, where combined costs exceed the sum of individual diseases. This phenomenon results from disease complexity (e.g., physiological differences in mental–physical multimorbidity treatment cumulatively drive higher healthcare costs), polypharmacy-related risks (e.g., adverse drug events and inappropriate prescriptions), and overlapping healthcare utilization (e.g., redundant diagnostics). Multimorbidity further amplifies costs through bidirectional pathways, such as inflammation escalation, impaired self-management and frailty-associated care demands, which compound these challenges (*8*). Conversely, most triad multimorbidity patterns exhibited a sub-additive effect, suggesting that combined spending is less than the sum of individual conditions. This may result from synergistic or detrimental effects in care-seeking behaviors, where the presence of multiple conditions influences how patients seek and receive care. These insights underscore the need for tailored interventions to effectively manage specific multimorbidity patterns, ensuring efficient and effective use of healthcare resources.

The findings highlight several key implications for clinical practice and policy development. First, optimizing comprehensive medical care models through multidisciplinary teams (including geriatricians, nurses, and rehabilitation specialists) could enhance clinical outcomes while shortening hospitalization stays (*9*). Second, implementing transitional care programs, such as pre-discharge planning and community health service integration, could minimize unplanned readmissions. Third, exploring alternative therapeutic approaches, such as traditional Chinese medicine, might offer cost-effective disease management options. From a policy perspective, current reimbursement systems inadequately address cost variations across multimorbidity patterns, potentially burdening vulnerable populations (*10*). Strategic reforms should focus on 1) shifting from disease-centered to patient-centered care models to reduce duplicate procedures and polypharmacy; 2) optimizing diagnosis-intervention packetage reimbursement payment systems and commercial insurance programs by incorporating more complex risk-adjusted multimorbidity patterns instead of simple Charlson Comorbidity Index; 3) public health priorities should balance high-prevalence and high-cost patterns, as the former dominate aggregate expenditures despite lower hospitalization costs; 4) improving primary care quality and accessibility for rural and low-income populations as prevention management. More evidence needs to be explored for multimorbidity management in China's aging population.

This study has several limitations that warrant acknowledgment. The analysis focused exclusively on primary diagnosis codes, excluded patients without chronic conditions, and utilized data from a single metropolitan area, which may limit the generalizability of findings to other populations and healthcare systems. Despite these constraints, the comprehensive nature of this study's dataset — encompassing real-world data from 273 public hospitals and medical institutions, analyzing 40 distinct chronic conditions, and providing detailed examination of both individual diseases and multimorbidity patterns — offers robust and reliable estimates for hospitalization expenditures among older adults.

In conclusion, this study quantifies the substantial direct hospitalization costs associated with chronic diseases and multimorbidity among older adults in Guangzhou City, underscoring the urgent need for targeted interventions and integrated care models. These findings provide essential evidence for policymakers and healthcare providers to develop comprehensive strategies for preventing and managing chronic diseases and multimorbidity. Such strategies should ultimately optimize resource allocation, improve patient outcomes, and reduce the overall economic burden on healthcare systems. Future research should examine diverse populations across different geographic regions and healthcare settings to enhance our understanding of the economic impact and evaluate the cost-effectiveness of various care delivery models, thereby extending the applicability of these findings to broader healthcare contexts.

Conflicts of interest: No conflicts of interest.

Ethical statement: This study utilized secondary anonymized patient data and therefore did not require informed consent. Ethical approval was obtained from the University of Nottingham Ningbo China prior to study initiation.

Funding: Supported by the National Natural

Science Foundation (Grant No.: 72174098). The funding organization had no role in study design, data collection, analysis, interpretation, or manuscript preparation.

doi: 10.46234/ccdcw2025.175

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Submitted: January 11, 2025
Accepted: July 06, 2025
Issued: August 01, 2025

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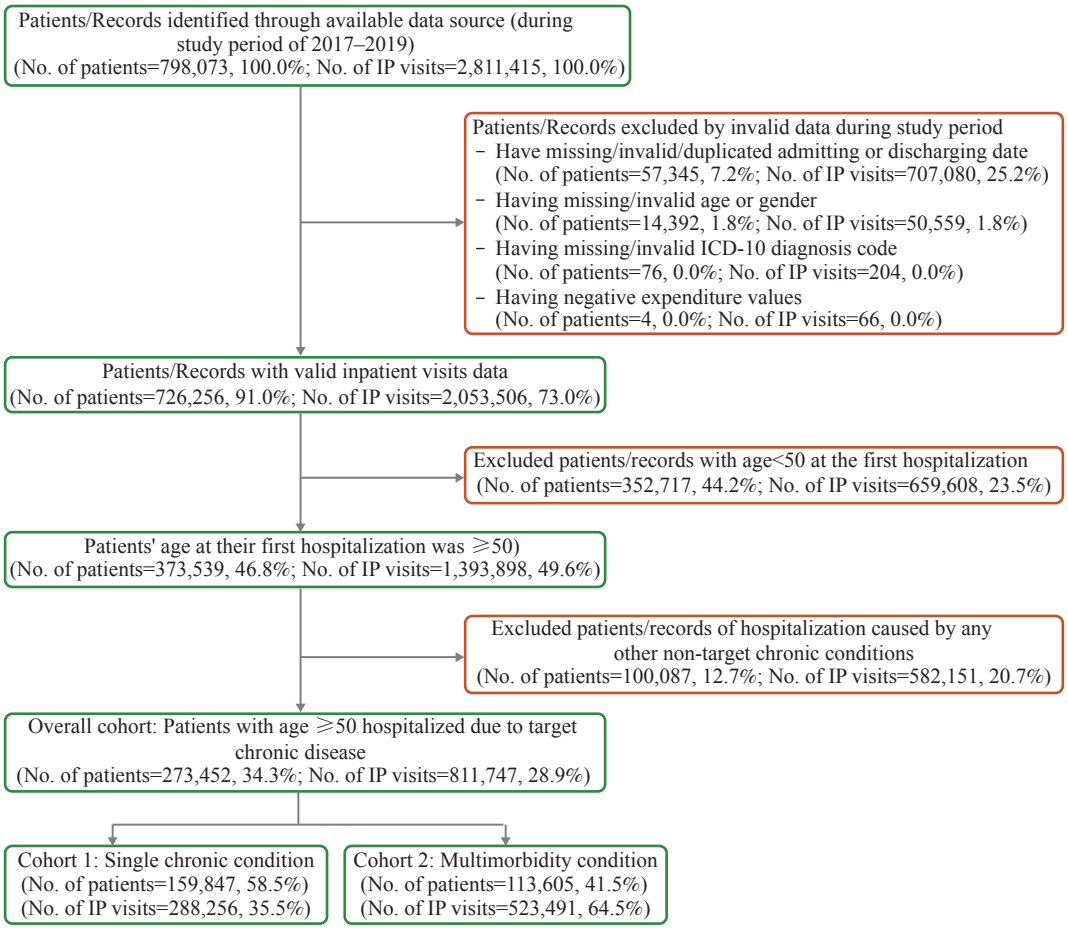
SUPPLEMENTARY MATERIALS

Chronic Conditions Considered in this Study

A total of 40 chronic conditions (Supplementary Table S1) were selected based on diseases most frequently cited in multimorbidity literature that were deemed to significantly impact long-term treatment outcomes and quality of life among elderly Chinese populations (*1*–*3*).



SUPPLEMENTARY FIGURE S1. Study flow diagram for population selection.
Abbreviation: No.=Number; IP=Inpatient.

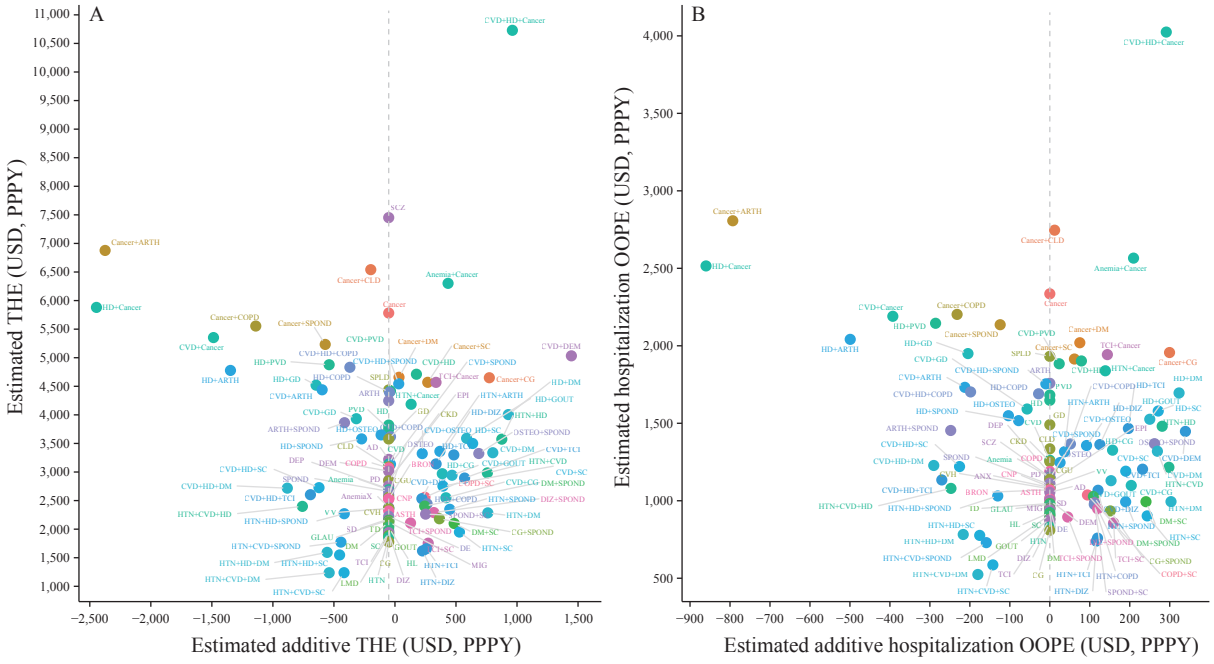
Statistical Methods

For descriptive analysis, continuous variables with skewed distributions of hospitalization expenditures (THE and OOPE) were presented as median (Q1, Q3), while normally distributed HCRUs were expressed as mean (±standard deviation). Between-group comparisons of mean measurements were conducted using t-tests and ANOVA, while median measurements were compared using non-parametric Wilcoxon rank sum tests and Kruskal-Wallis rank sum tests. Chi-square tests were employed to assess differences in categorical variables.

In GLM analysis, the association between multimorbidity (binary or multivariate) and hospitalization expenditures (annual total and OOPE) was modeled as:

$$\ln\left(E\left(Y_i|X_i\right)\right) = \beta_{0i} + \beta_{1i}x_{multimorbidity_i} + \beta_{2i}x_{agei} + \beta_{3i}x_{genderi} + \beta_{4i}x_{insurancetypei} + \varepsilon_i$$

To estimate hospitalization spending related to specific chronic diseases and multimorbidity patterns, and to assess super-additive, additive, and sub-additive effects, we employed the following model:



SUPPLEMENTARY FIGURE S2. Estimated annual hospitalization expenditures for chronic diseases and multimorbidity patterns. (A) Estimated Annual Total Hospitalization Expenditure; (B) Estimated Annual Hospitalization Out-of-Pocket Expenditure.
Abbreviation: THE=total hospitalization expenditure; PPPY=per patient per year; OOPE=out-of-pocket expenditure.

$$\ln\left(E\left(Y_i|X_i\right)\right) = \beta_{0i} + \sum_{j=1}^{J} \beta_{ij} dx_{ij} + \sum_{k=1}^{K} \beta_{ik} dyad_{ik} + \sum_{l=1}^{L} \beta_{il} triad_{il} + \beta_{2i} x_{agei} + \beta_{3i} x_{genderi} + \beta_{4i} x_{insurancetypei} + \varepsilon_i$$

Where i represents the patient, Y_i denotes the outcome variables including annual THE and annual hospitalization OOPE. X_i represents a matrix of explanatory variables and covariates where dx_{ij} indicates each of the 40 target chronic conditions, $dyad_{ik}$ and $triad_{il}$ represent the interaction terms for possible chronic condition dyads and triads, respectively. x_{agei}, $x_{genderi}$, and $x_{insurancetypei}$ are covariates and ε_i represents the error term.

All expenditure variables were adjusted for inflation to 2019 Chinese Yuan using the national Consumer Price Index and converted to 2019 US dollars (1.0 CNY = 0.1449 USD). All statistical analyses were performed using SAS (version 9.4, SAS Institute Inc., Cary, NC, USA).

SUPPLEMENTARY TABLE S1. List of chronic conditions with ICD-10 codes.

Chronic condition name	ICD-10 Code
Cancers	
Cancer	C00-C97
Heart/vascular diseases	
Hypertension (HTN)	I10-I15
Varicose veins (VV)	I83
Cerebrovascular disease (CVD)	I60-I69
Heart disease (HD)	I05-I09, I20-I27, I34-I37, I44-I49, I50, I51.9
Peripheral vascular disease (PVD)	I70-I73.9
Anemia	D50-D64
Endocrine/metabolic diseases	
Thyroid disorders (TD)	E02-E03, E05
Diabetes mellitus (DM)	E10-E14
Gout	E79, M10
Lipoprotein metabolism disorder (LMD)	E78
Respiratory diseases	
Chronic nasopharyngitis (CNP)	J31.0-31.2, J32
Chronic obstructive pulmonary disease (COPD)	J44
Asthma (ASTH)	J45-J46
Bronchiectasis (BRON)	J47
Neurological/Mental disorders	
Alzheimer's disease (AD)	G30
Epilepsy (EPI)	G40
Transient cerebral ischemia (TCI)	G45
Parkinson's disease (PD)	G20-G22
Migraine (MIG)	G43, G44
Anxiety disorders (ANX)	F40-F41
Schizophrenia (SCZ)	F20
Major depressive disorder (DEP)	F32-F33
Dementia (DEM)	F00-F03
Sleep disorders (SD)	F51, G47
Dizziness and vertigo (DIZ)	R42, H81.0-H82
Musculoskeletal/Dermatological conditions	
Osteoporosis (OSTEO)	M80-M82
Arthropathy (ARTH)	M15-M19
Spondylosis (SPOND)	M45-M49
Dermatitis and eczema (DE)	L20-L30
Digestive/Genitourinary diseases	
Gallstone disease (GD)	K80
Chronic liver disease (CLD)	K70, K71.3-K71.5, K71.7, K72.1, K73-E76
Chronic gastric ulcer (CGU)	K25.4-K25.9
Chronic gastritis (CG)	K29.3-K29.5
Chronic kidney disease (CKD)	N03-04, N06-N08, N11, N13

Continued

Chronic condition name	ICD-10 Code
Spleen disease (SD)	D73
Chronic viral hepatitis (CVH)	B18
Eye/Ear diseases	
Senile cataract (SC)	H25, H28.0-H28.2
Glaucoma (GLAU)	H40-H42
Hearing loss (HL)	H90-H91

Abbreviation: ICD-10=International classification of diseases, 10th revision, Chinese edition.

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3. Zhang Y, Chen C, Huang LF, et al. Associations Among multimorbid conditions in hospitalized middle-aged and older adults in China: statistical analysis of medical records. JMIR Public Health Surveill 2022;8(11):e38182. https://doi.org/10.2196/38182.