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Title: The impact of mental and physical multimorbidity on healthcare utilization and health spending in China: a nationwide longitudinal population-based study

Running title: Impact of multimorbidity on healthcare utilization and health spending

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Abstract

Background: In China, little evidence exists on the effect of mental and physical multimorbidity on individuals and the health system. This study aims to examine the prevalence of mental-physical multimorbidity and its impact on health service utilization and health expenditures.

Methods: We conducted a panel study using two waves of data (in 2011 and 2015) from the China Health and Retirement Longitudinal Study, including 10,181 participants aged 45 years and older. Generalized linear regression models were used to assess the association of multimorbidity with total health expenditure and out-of-pocket expenditure (OOPE) on outpatient and inpatient care. Random-effects logistic regression models were used to examine the impact of multimorbidity on outpatient visits, admission to hospital and incidence of catastrophic health expenditure.

Results: Overall, 3,210 participants (31.53% of 10,181) had mental-physical multimorbidity in 2015 in China. Compare to patients with a single physical disease, individuals with physical-mental multimorbidity had over 150% of the increase in the number of outpatient visits and days of hospitalization. The percentage change of OOPE for outpatient and inpatient care was 156.8% and 163.6%, respectively. Mental-physical multimorbidity was associated with an increased likelihood of experiencing catastrophic health expenditure (OR=2.205, 95% CI=2.048, 2.051).

Conclusion: Multimorbidity, particularly mental-physical multimorbidity, is associated with higher levels of health service use and a greater financial burden to individuals in China. Healthcare system needs to shift from single-disease models to new financing and service delivery models to more effectively manage mental-physical multimorbidity.

Keywords: mental-physical multimorbidity, healthcare utilization, health spending, China, longitudinal analysis

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Key points

- To our knowledge, this is the first longitudinal analysis to estimate the effects of mental-physical multimorbidity on health service use and catastrophic health expenditure in a nationally representative study in China.
- Both physical multimorbidity and mental-physical multimorbidity are common in China.
- Multimorbidity was associated with increased outpatient and inpatient service use, out-of-pocket expenditures, as well as catastrophic health expenditure, compared with single physical health conditions.
- China, home to the largest ageing population in the world, should develop targeted policies to ensure appropriate health services and financial risk protection for individuals with mental-physical multimorbidity.

1 Introduction

There has been a rapid recent increase in the prevalence of common mental disorders in China. A report by the China Mental Health Survey (CMHS) found that the life-time prevalence of mental disorders, including anxiety and depression rose to 16.6% among the Chinese population in 2013, which is substantially higher than in 1982 (1.3%), 1993 (1.4%), and 2002 (13.2%).[1] A strong bidirectional link has been observed between mental disorders and physical conditions. For example, patients with major depression may be at high risk of developing one or more physical condition(s) because of health risk behaviours and poor adherence to medication.[2–5]In addition, depressive symptoms are common in people with physical conditions. A recent longitudinal study found that middle-aged and older Chinese adults with one, two, and three or more physical conditions had a 21%, 66%, and 111% greater risk, respectively, for the presence of depressive symptoms, compared with those without physical conditions.[6] The strong associations between mental disorders and physical conditions suggest that mental-physical multimorbidity is a public health challenge in China, yet extant research on multiple chronic disease has not addressed this issue.

Multimorbidity, defined as two or more co-existing chronic diseases in the same person, has become one of the main challenges in healthcare in China and worldwide.[7-9] Globally, the aging of populations increases exposure to risk factors for disease, and as such the prevalence of multimorbidity is likely to increase rapidly.[9] In China, a systematic review published in 2015 showed that the prevalence of multimorbidity among the general population aged 60 years or older ranged from 6·4% to 76.5%.[10] More recently, the reported prevalence of multimorbidity is approximately 50% for middle-aged and older Chinese adults.[11,12]Although different operational definitions and measures of multimorbidity are detected in the literature, the number of prescriptions, referrals, outpatient visits, hospital admissions, and expenditures is consistently found to be significantly associated with an increase in the number of chronic diseases in China and other countries.[13–19] However, these previous studies have focused on the coexistence of specific illness and a relatively small number of

physical diseases, such as cardiovascular diseases, diabetes, and cancer, rather than on the whole range of chronic morbidity affecting middle-aged and older persons.[8,9,13-19] Few studies have been examined the prevalence rates and influences of mental-physical multimorbidity in China.[6,12,20,21]Published studies have mainly examined the influences on healthcare and costs among regional-or district-level populations in China using cross-sectional study designs.[15-17,20,21] Very few of these studies have used nationally-representative data and performed a longitudinal analysis.[6,8] A recent nationally representative study estimated the different patterns of physical health conditions with depression among middle-aged and older adults in China. No research to date has compared the health care utilization and cost impacts of comorbidity of chronic mental disorders and physical diseases and physical multimorbidity.[8]

To estimates trends and health-care related economic burden of prevalence rates of patients with complex health problems, studies addressing multimorbidity should take into account not only the cumulative effect of a small number of physical chronic diseases, but also the simultaneous presence of physical diseases/symptoms, cognitive and physical dysfunctions, and mental disorders. In 2006, the Chinese Government published guidelines to emphasize community based management of chronic diseases, where mental disorders were considered as chronic diseases that should be cared for in community-level or primary care.[22] Understanding the multimorbidity rates of mental disorders and physical conditions, and how they affect the health care use, could therefore have important implications for the improvement of service delivery in primary care and the design of health policies in China. This will be helpful for tailoring health service resources to the health needs of the Chinese population, and critical for improving the clinical treatment, disease self-management and reform of current Chinese healthcare system.

Therefore, the aim of this paper is to fill this gap by estimating the prevalence rates and combined impact of common mental disorders and physical conditions on access to healthcare utilization and health spending in China. The data used in the analysis

represent a population group of more than 300 million people in China.[23] The present study will be the first panel analysis to examine mental-physical multimorbidity rates and its impact on healthcare service use and catastrophic health expenditures in China.

2 Methods

2.1 Sample and data

This study used longitudinal data from two waves of the China Health and Retirement Longitudinal Study (CHARLS) conducted in 2011 and 2015. CHARLS is a biennial survey conducted by the National School of Development at Peking University, which aimed to be representative of Chinese residents aged 45 years and older. The data were collected in a survey in which four-stage, stratified, cluster sampling was used to select eligible individuals.[24] Briefly, 150 counties were firstly selected proportional to population size. Then three villages/communities were selected from each county as primary sampling units (PSUs). In each of the 450 PSUs, 80 households were randomly selected, with 24 for investigation. If the household had persons aged 45 years and over, one of them was randomly chosen, and both respondents and their spouses were interviewed using structured questionnaires. A detailed description of the survey objectives and methods has been reported elsewhere [27].[24] The main questionnaire includes information on basic demographics, health status and functioning, health care and insurance, work, retirement and pensions, income and consumption, household assets, and several biomarkers.

A total of 17,708 participants from 10,257 households were interviewed; the overall household response rate was 80·5%. Ongoing follow-up surveys were conducted every two years. For this study, we used longitudinal data based on the baseline and second follow-up wave of CHARLS (14,192 respondents without losses to follow-up). After removing those individuals with missing values in either dependent

or independent variables, our final sample consisted of 10,181 respondents (71·7% of those reported no loss to follow-up).

2.2 Measures

In this study, multimorbidity was defined as the presence of two or more chronic diseases.[8] A total of fifteen chronic diseases were used to measure physical multimorbidity (≥ 2 physical diseases and 0 mental disorder in the same individual) and mental-physical multimorbidity (≥ 1 physical disease and ≥ 1 mental disorder in the same individual). Physical conditions included hypertension, diabetes, dyslipidaemia (measured by biomarkers or blood test information), and ten self-reported diagnosed chronic diseases (heart disease, stroke, cancer, chronic lung disease, digestive disease, liver disease, kidney disease, memory-related disease, arthritis and asthma). We counted the number of chronic diseases for each participant, identifying those with multimorbidity.

Mental conditions included self-reported diagnosed psychiatric disease and depression which was assessed by the 10-item Center for Epidemiologic Studies Depression Scale (CES-D).[25] CES-D is a validated mental health assessment tool for older people in China. [25] Participants rated each domain on a four-point scale, ranging from (1) rarely, (2) some days (1–2 days per week), (3) occasionally (3–4 days per week) to (4) most of the time (5–7 days per week). Responses were coded as 0 (rarely) to 3 (most of the time) for the negative questions; For two positive questions, the items were reversed as 3 (rarely) to 0 (most of the time). The scores of the CESD-10 range from 0 to 30. In this study, individual participants who had a CESD-10 score of ≥ 10 were defined as having depressive symptoms. A binary variable was also constructed.

In CHARLS, each respondent's systolic blood pressure (SBP) and diastolic blood pressure (DBP) were recorded three times by a trained nurse using a HEM-7112 electronic monitor. Diagnosed hypertension was defined as systolic blood pressure ≥140 mmHg and/or diastolic blood pressure≥90 mmHg, and/or being on anti-hypertensive medication for raised blood pressure.[26] In this study, diabetes was

defined by: 1) a fasting plasma glucose level of ≥126 mg/dL (7.0 mmol/L); and/or 2) HbA1c concentration of ≥6.5%; and/or 3) being insulin treatment and/or taking medication for raised blood sugar.[27] Dyslipidaemia was defined by: 1) total cholesterol (TC) ≥ 240 mg/dL (6.22 mmol/L); and/or 2) low-density lipoprotein cholesterol (LDL-C) ≥ 160 mg/dL (4.14 mmol/L); and/or 2) high-density lipoprotein cholesterol (HDL-C) <40 mg/dL (1.04 mmol/L); and/or 2) triglyceride (TG) ≥ 200 mg/dL (2.26 mmol/L); and/or 2) taking anti-dyslipidaemia medication.[25]

Use and frequency of utilization of healthcare services were self-reported by respondents through the following questions: "Have you had any outpatient visit in the past month; and any hospital stay in the past year?" "How many times did you visit a general hospital, specialized hospital, clinic or other medical facility for outpatient care in the past month?" and "How many days did you stay in hospital over the past year?" CHARLS also collected the information on how much respondents paid in total and how much out-of-pocket (deducting the reimbursed expenses) for their outpatient visits during the last month and inpatients visit during the last year. The same information was also collected on spouses of all participants. The total annual health expenditure was defined as the sum of spending on outpatient and inpatient care provided during the last year, before reimbursement from health insurance. As the number of outpatient visits and total expenditure for outpatient care measured for one month, this study calculated the one-year outpatient visits and the costs for outpatient care by multiplying

We defined a household as incurring catastrophic health expenditures (CHE) when out-of-pocket expenditure on health equalled or exceeded 40% of a household's capacity to pay.[28] In this study, the capacity to pay was defined as the non-food household consumption expenditure. This was considered the denominator. The numerator was the sum of respondents and their spouses' out-of-pocket expenditure for outpatient and inpatient care in the past year. A binary variable was defined which indicated whether the household of participants experienced catastrophic health expenditures or not.

2.3 Statistical analysis

We used the Chi-square test to explore the socio-demographic disparity in the prevalence of multimorbidity. The random-effects logistic regression model was applied to estimate the association of multimorbidity with outpatient visits, admission to hospital as well as the incidence of CHE. For total health expenditure and the OOPE analysis, we used the generalized linear regression models (GLM) with log link and gamma distribution. For the frequency of outpatient visits and days of hospitalization, we used the GLM with log link and poisson distribution. Predicted values of outpatient and inpatient care as well as health expenditures were estimated using the GLM with an adjustment of all covariates. We also reported the percentage change of healthcare utilization and OOPE between single physical disease and physical-mental multimorbidity groups. For the logistic regression analysis, the adjusted odds ratio (OR) and 95% confidence intervals (CI) were reported. For the GLM analysis, the coefficient and 95% CI were reported.

We included the following variables as covariates: age, gender, marital status (married and partnered, unmarried and others), education (primary school and below, secondary school, college and above), residence (rural, urban), geographical region (east, central and west), economic status quartiles (yearly per capita household consumption expenditure), health insurance (Urban Employee Basic Medical Insurance (UEBMI), Urban Resident Basic Medical Insurance (URBMI), New Rural Cooperative Medical Scheme (NCMS), other insurance, without insurance), medical facility in village/community surveyed (Yes/No), and travel time to the nearest medical facility (<5 minutes, 5-30 minutes, and ≥30 minutes).

2.4 Sensitivity analyses

We conducted sensitivity analyses to check the robustness of our findings. Random-effects negative binomial regression models were performed to investigate relationships between the multimorbidity and the frequency of outpatient visits and stays in the hospital. We reported the incidence rate ratio (IRR) and 95% CI. All

statistical analyses were weighted to account for the complex, multi-stage design, and loss of follow up the CHARLS datasets. All analyses were performed using STATA 15.0 (Stata Corp, College Station, TX, USA). $P < 0.05$ was considered to be statistically significant.

3 Results

Table 1 presents the respondents' socio-demographic characteristics of the baseline survey. There was roughly an equivalent proportion of female and male respondents, of which 23.9% were aged 65 years. 67.8% of the respondents had completed primary school or less, and 65.7% were residing in rural areas. More than 94.1% of respondents had at least one kind of health insurance, with 78.8% of all respondents enrolled in the NCMS.

Among the 10,181 participants, 3,073 (30.18 %) in 2011 and 3,926 (38.56%) in 2015 had physical multimorbidity, and 3,217 (31.60 %) in 2011 and 3,210 (31.53%) in 2015 had physical-mental multimorbidity. Overall, the prevalence of physical multimorbidity was higher in people who: were older; male; married or partnered; had a high education level; had a higher socioeconomic status; had health insurance; and lived in an urban area and the eastern region. Conversely, the prevalence of physical-mental multimorbidity was higher in people who: were female; unmarried; had a low education level; low socioeconomic status; did not have health insurance; and lived in a rural area, and/or the Western region. **(Table 1)**

[Insert Table 1]

The frequency of outpatient visits and number of days in the hospital was significantly higher for patients with multimorbidity than their counterparts with single physical disease. Patients with physical-mental multimorbidity had more outpatient visits and longer stays of hospitalization than patients with physical multimorbidity. (Figure 1) Compare to patients with a single physical disease, individuals with physical-mental multimorbidity had over 150% of the increase in the

number of outpatient visits and days of hospitalization, adjusting for sociodemographic characteristics. The percentage change of OOPE for outpatient and inpatient care was 156.8% and 163.6%, respectively. (Table 2)

[Insert Figure 1, Table 2]

As displayed in **Table 3**, a higher number of chronic conditions was associated with higher levels of healthcare utilisation for both outpatient and hospital care. People with both physical multimorbidity and physical-mental multimorbidity were more likely to have outpatient visits (OR=1.935, 95% CI=1.934, 1.937 and OR=2.856, 95% CI=2.854, 2.859, respectively) and admission to hospital (OR=1.924, 95% CI=1.922, 1.926, and OR=2.486, 95% CI=2.483, 2.488, respectively), compared to people with single physical diseases. In addition, older patients were more likely to report inpatient visits than younger patients. Affluent people were more likely to utilise outpatient healthcare and hospital healthcare than those in the least deprived quartile. People with health insurance had a higher probability of outpatient and inpatient care utilisation than people with no health insurance. Compared with single disease patients, people with physical-mental multimorbidity were more likely to experience catastrophic health expenditure (OR=2.205, 95% CI=2.048, 2.051)

[Insert Table 3]

As displayed in **Table 4**, the prevalence of multimorbidity had a positive relationship with healthcare expenditure. The total health expenditure was higher for patients with physical-mental multimorbidity than those people with the single physical disease (for physical multimorbidity: coefficient=0.426, 95% CI=0.146, 0.706; for physical-mental multimorbidity: coefficient=0.903, 95% CI=0.600, 1.207, respectively). Compared with single disease patients, people with physical-mental multimorbidity were more likely to have out-of-pocket spending on outpatient care (coefficient=0.943, 95% CI=0.578, 1.308) and hospitalisation (coefficient=0.966, 95% CI=0.656, 1.283). Moreover, people of higher socioeconomic status were more

likely to spend more out-of-pocket money on outpatient and inpatient care than those of lower economic status.

[Insert Table 4]

In terms of sensitivity analyses, we found similar associations between multimorbidity and frequency of outpatient and inpatient care, by using negative binomial regression models. The results were consistent with our original findings showing physical multimorbidity was associated with an increase in the number of outpatient visits (IRR=1.705, 95% CI=1.528, 1.901) and days of hospitalisation (IRR=1.975, 95% CI=1.707, 2.285). Similarly, physical-mental multimorbidity was also positively associated with the number of outpatient visits (IRR=2.383, 95% CI=2.138, 2.656) and the length of hospitalisation (IRR=2.442, 95% CI=2.108, 2.830). **(Table S1)**

4 Discussion

To our knowledge, this is the first panel study to examine the relationship between mental-physical multimorbidity, and healthcare use and financial protection among a nationally-representative sample of the Chinese population. We also compared the effects of mental-physical multimorbidity and physical multimorbidity on health care use and expenditure.

4.1 Principal findings

Consistent with previous findings, we found that both physical multimorbidity and mental-physical multimorbidity are common in China.[7,13,14] This suggests that longitudinal investigations, regular physical health checks, and close clinical monitoring are needed to detect physical multimorbidity and mental-physical multimorbidity over time. Surveillance strategies are required to monitor the medication compliance and establish the burden of compound effects of mental-physical multimorbidity.

Our study also corroborated previous local studies in China with extended and robust

evidence on the positive association between physical multimorbidity and healthcare use and costs at the national level.[15,20-21]A higher level of healthcare utilization among patients with more chronic conditions could be due to the complexity of health conditions that require more diverse and intensive care, which then increase the healthcare cost. [14]

Our study provides new national evidence on the potential burden of mental-physical multimorbidity in China. Compared with single or multiple physical diseases, the findings of our study suggest that the co-occurrence of mental and physical conditions might pose a greater challenge for individuals and healthcare systems. The greater number of outpatient visits and hospital admissions, the longer length of stay, higher OOPE and CHE in patients with mental-physical multimorbidity further underscores the need for more effective approaches for the management of patients with mental-physical multimorbidity. There are several reasons why people with mental-physical multimorbidity may use healthcare more and incur greater healthcare costs. First, stigma discourages disclosure, difficulties with reporting medical problems, and a tendency to express depression somatically among older Chinese adults can lead to inaccurate early diagnosis of mental illness, under treatment, and poor management of mental illness for people with physical conditions, resulting in more visits or longer treatment as well as costs.[29,30] Second, poorer medication compliance, the effects of polypharmacy and drug-drug and drug-disease interactions can result in healthcare visits and associated costs for people with mental-physical multimorbidity.[31-34] Consequently, more attention to individuals with mental-physical multimorbidity should be given in the Chinese National Medium and Long Term Health Plan (2017–2025) and other national health strategies for chronic disease control in China. [35]

4.2 Policy implications

To tackle the growing burden of multimorbidity in China, the health system needs to shift from single-disease models to new financing and service delivery models that more effectively manage multimorbidity, particularly mental-physical multimorbidity.

A strong primary healthcare system led by generalist physicians (trained family doctors) working with multi-disciplinary teams is well recognized to be essential for cost-effective management of multimorbidity.[31] A current trial in China is testing the roll-out of the 'people-centered integrated care' program, which incentivizes general practices to manage chronic disease patients holistically, and is an example of such a new approach [78-79].[36,37] However, although China has officially promoted the delivery of mental health services in community-level or primary health care since 2006, actualization of this approach is challenged by the attributes, knowledge, and beliefs of providers, and complex service user needs.[38] A multi–disciplinary team with psychiatric and physiological competencies has not been well developed in primary health care in China.

As highlighted in blueprint for protecting physical health in people with mental illness issued by the Lancet Psychiatry Commission, to integrate care for mental-physical multimorbidity into primary care, the findings of this study make the following recommendations for policy and practice: (1) Strengthen cooperation between China state and national governments, hospitals, public health organizations, and medical education institutions, and other relevant sectors to build multidisciplinary teams to support the management of patients with multimorbidities;[22] (2) train multidisciplinary teams in mental health settings or multidisciplinary general practitioners in primary healthcare centres; (3) monitor lifestyle behaviours using digital technologies, and improve the regular screening and monitoring of those high-risk patients with both physical conditions and mental disorders to increase the accuracy of diagnosis and early disease detection; and (4) strengthen the efficacy of multidisciplinary lifestyle interventions in the general population for reducing the risk of cardiometabolic-related morbidity.[31,39] Overall, efforts are needed at the primary, secondary, and tertiary levels of healthcare to reduce the prevalence and burden of multimorbidity.

4.3 Strengths and limitations

This study examined the epidemiology of mental-physical multimorbidity and explored its impact on healthcare use and costs based on a longitudinal, large,

nationally representative sample of the Chinese population, which provides robust estimates of key variables. However, there are several limitations to our study. First, the use of some self-reported measures of chronic disease (except hypertension, hypertension, diabetes, dyslipidaemia and depression) may underestimate their prevalence. Second, the CHARLS questionnaire did not ask about all chronic diseases typically included in clinical database studies. Further studies examining the effect of multimorbidity due to other mental and physical conditions (e.g. Alzheimer's disease, gout, osteoporosis, anxiety and schizophrenia) are warranted. Third, healthcare utilization and health expenditure were not specific for chronic diseases included in CHARLS. Fourth, we examined the effect of multimorbidity on healthcare utilisation and expenditure by simply counting only 15 chronic diseases without accounting for the different clusters and severity of chronic diseases. This could underestimate the effect of multimorbidity on health service use and health expenditure, and it might be difficult to distinguish the specific jointed effects of severe physical-mental multimorbidity. Future research should apply unequal weights according to the type and severity of chronic conditions to explore the impact of multimorbidity. Finally, the analyses controlled for individual socio-demographic factors, but did not control for supply-side factors including supplies of hospital beds, primary care physicians and local or regional hospitalization rate, which may influence our estimates. In addition, this study only included middle-aged and older populations in China. The prevalence of multimorbidity and its impacts among younger populations should be considered in future studies.

5 Conclusion

Our findings indicate that multimorbidity was prevalent in China. Compared to people with single or multimorbidity of physical diseases, mental-physical multimorbidity were associated with more use of and higher out-of-pocket for outpatient and inpatient healthcare, as well as higher catastrophic health expenditure. Specifically, the co-occurrence of mental and physical conditions was significantly associated with more outpatient visits, hospital admissions, longer length of stay, and higher OOPE,

as well as higher catastrophic health expenditure. Differences in social-demographic characteristics were also observed between physical and mental-physical multimorbidity. Our findings suggest that China's healthcare systems need to shift from single-disease models to new financing and service delivery models that effectively manage mental-physical multimorbidity.

Appendix

Table S1. The association of physical-mental multimorbidity with the frequency of health service use in China.

Contributors

YZ and LH conceived and designed the study. YZ did the initial analysis and supervised data analysis. YZ and LH wrote the first draft of the paper, and PZ, OB, TS, SL, TH and LH critically revised the first draft. All authors reviewed and had final approval of the submitted and published versions.

Ethical approval

The Biomedical Ethics Review Committee of Peking University approved the CHARLS study, and all interviewees were required to provide informed consent. The ethical approval number was IRB00001052–11015.

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Declaration of Interests

The authors have declared that no competing interests exist.

Availability of data and material

The data that support the findings of this study are available in the [http://charls.pku.edu.cn/index/en.html]. [The China Health and Retirement Longitudinal Study (CHARLS)] Yaohui Zhao, et al.; 2018; Harmonized CHARLS; the Gateway to Global Aging Data; Version C; http://charls.pku.edu.cn/pages/data/harmonized_charls/en.html.

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Table 1. Characteristics of the baseline survey, prevalence of physical and mental multimorbidity in China in 2015

	Baseline characteristics		Prevalence of physical multimorbidity		Prevalence of mental-physical multimorbidity	
Variable	N	%	2011	2015	2011	2015
Overall	10,181	100·0	3,073 (30·18%)	3,926 (38·56%)	3,217 (31·60%)	3,210 (31·53%)
Gender						
Male	4,988	48·99	1,633 (32·74%)	2,093 (41·96%)	1,237 (24·80%)	1,257 (25·20%)
Female	5,193	51·01	1,440 (27·73%)	1,833 (35·30%)	1,980 (38·13%)	1,953 (37·61%)
Age, years						
45-55	3,785	37·18	972 (25·68%)	779 (32·27%)	981 (25·92%)	664 (27·51%)
55-65	3,959	38·89	1,241 (31·35%)	1,528 (38·44%)	1,326 (33·49%)	1,258 (31·65%)
65-75	1,816	17·84	642 (35·35%)	1,072 (40·45%)	674(37·11%)	972 (36·68%)
≥75	621	6·10	218 (35·10%)	547 (47·90%)	236 (38·00%)	316 (27·67%)
Marital status						
Married and partnered	9,030	88·69	2,756 (30·52%)	3,394 (38·96%)	2,715 (30·07%)	2,646 (30·38%)
Unmarried and others	1,151	11·31	317 (27·54%)	532(36·19%)	502 (43·61%)	564 (38·37%)
Education level						
Primary school and below	6,904	67·81	2,016 (29·20%)	2,577 (37·33%)	2547 (36·89%)	2,514 (36·41%)
Secondary school	2,165	21·27	689 (31·82%)	888 (41·02%)	499 (23·05%)	509 (23·51%)
College and above	1,112	10·92	368 (33·09%)	461 (41·46%)	171 (15·38%)	187 (16·82%)
Residence status						
Urban	3,493	34·31	1,185 (33·92%)	1,500 (42·94%)	904 (25·88%)	871 (24·94%)
Rural	6,688	65·69	1,888 (28·23%)	2,426 (36·27%)	2,313 (34·58%)	2,339 (34·97%)
Region						
East	3,715	36·49	1,147 (30·87%)	1,467 (39·49%)	903(24·31%)	901 (24·25%)
Central	3,925	38·55	1,209 (30·80%)	1,521 (38·75%)	1,288 (32·82%)	1,296 (33·02%)
West	2,541	24·96	717 (28·22%)	938 (36·91%)	1,026 (40·38%)	1,013 (39·87%)
PCE, quartile						
Q1 (deprived)	2,550	25·05	696 (27·29%)	970 (38·10%)	876 (34·35%)	851 (33·42%)
Q2	2,541	24·96	767 (30·18%)	944 (37·05%)	855 (33·65%)	809 (31·75%)
Q3	2,545	25·00	745 (29·27%)	992 (39·01%)	832 (32·69%)	798 (31·38%)
Q4 (affluent)	2,545	25·00	865 (33·99%)	1,020 (40·09%)	654 (25·70%)	752 (29·56%)
Health insurance						
None	599	5·88	159 (26·54%)	269 (34·36%)	209 (34·89%)	279 (35·63%)
UEBMI	833	8·18	315 (37·82%)	494 (47·18%)	146 (17·53%)	176 (16·81%)
URBMI	490	4·81	168 (34·29%)	226 (43·71%)	146 (29·80%)	147 (28·43%)
NCMS	8,021	78·78	2,320 (28·92%)	2,839 (37·29%)	2676 (33·36%)	2,557 (33·59%)
Others	238	2·34	111 (46·64%)	98 (44·34%)	40 (16·81%)	51 (23·08%)

Notes: Data are given as number (percent) unless otherwise indicated. PCE, Per capita household annual consumption expenditure. UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NCMS, New Rural Cooperative Medical Scheme; Others, government healthcare, private medical insurance and so on.

Table 2. Predictive value of health service utilization and health expenditures by multimorbidity group

Variable	Predictive value	95% CI		Percentage change
Number of outpatient visits				
Single physical disease	2.91	2.43	3.39	-
Physical multimorbidity	5.10	4.57	5.64	75.5%
Physical-mental multimorbidity	7.53	6.76	8.30	158.8%
Days of hospitalization				
Single physical disease	0.09	0.08	0.11	-
Physical multimorbidity	0.18	0.16	0.20	93.1%
Physical-mental multimorbidity	0.24	0.21	0.27	157.4%
OOPE for outpatient care				
Single physical disease	103.2	67.6	138.8	-
Physical multimorbidity	142.5	107.9	177.0	38.0%
Physical-mental multimorbidity	265.1	193.9	336.4	156.8%
OOPE for inpatient care				
Single physical disease	403.1	294.7	511.5	-
Physical multimorbidity	857.0	691.1	1022.8	112.6%
Physical-mental multimorbidity	1062.4	853.7	1271.1	163.6%
Total health expenditure				
Single physical disease	2418.7	1789.1	3048.4	-
Physical multimorbidity	3703.2	3099.8	4306.7	53.1%
Physical-mental multimorbidity	5969.5	4784.1	7155.0	146.8%

Notes: Predicted values were estimated using generalized linear regression models with an adjustment of sociodemographic characteristics. The percentage change was calculated by taking the single physical disease as a reference group. OOPE, out-of-pocket expenditure; CI, confidence interval.

Table 3. Association of physical and mental multimorbidity with outpatient visits, admission to hospital as well as incidence of CHE

Variable (reference)	Outpatient visits			Admission to hospital			Catastrophic health expenditure		
	OR	95% CI		OR	95% CI		OR	95% CI	
No. of chronic diseases									
(Single physical disease)	Ref			Ref			Ref		
Physical multimorbidity	1.935	1.934	1.937	1.924	1.922	1.926	1.276	1.275	1.277
Physical-mental multimorbidity	2.856	2.854	2.859	2.486	2.483	2.488	2.050	2.048	2.051
Year (2011)	Ref			Ref			Ref		
2015	1.052	1.051	1.052	1.896	1.895	1.897	1.562	1.562	1.563
Gender (Male)	Ref			Ref			Ref		
Female	1.137	1.136	1.137	0.951	0.951	0.952	0.966	0.965	0.966
Age, years (45-55)	Ref			Ref			Ref		
55-65	0.865	0.864	0.865	1.424	1.423	1.425	1.202	1.201	1.202
65-75	0.956	0.955	0.957	2.064	2.062	2.066	1.577	1.576	1.579
≥75	1.003	1.002	1.004	2.910	2.906	2.913	1.740	1.738	1.742
Marital status (Married and partnered)	Ref			Ref			Ref		
Unmarried and others	1.013	1.012	1.014	1.091	1.090	1.092	0.456	0.455	0.456
Education (Primary school and below)	Ref			Ref			Ref		
Secondary school	1.082	1.081	1.082	1.200	1.199	1.201	1.083	1.082	1.083
College and above	1.236	1.235	1.237	1.062	1.061	1.063	0.967	0.966	0.968
Residence status (Urban)	Ref			Ref			Ref		
Rural	1.103	1.102	1.104	1.053	1.053	1.054	1.260	1.259	1.261
Region (East)	Ref			Ref			Ref		
Central	0.977	0.976	0.977	1.275	1.274	1.276	1.336	1.335	1.337
West	1.167	1.167	1.168	1.726	1.724	1.727	1.263	1.263	1.264
PCE, quartile (Q1 (deprived))	Ref			Ref			Ref		
Q2	1.193	1.192	1.194	1.245	1.243	1.246	1.102	1.101	1.103
Q3	1.071	1.070	1.072	1.639	1.637	1.640	1.031	1.031	1.032
Q4 (affluent)	1.446	1.445	1.447	2.014	2.012	2.016	1.011	1.010	1.012
Health insurance (None)	Ref			Ref			Ref		
UEBMI	1.349	1.347	1.350	1.413	1.411	1.415	0.931	0.929	0.932
URBMI	1.366	1.364	1.368	1.437	1.435	1.440	1.232	1.230	1.234
NCMS	1.681	1.679	1.683	1.197	1.196	1.199	1.459	1.458	1.461
Others	2.090	2.086	2.093	1.099	1.097	1.102	1.157	1.155	1.160
Medical facility in village/community									
surveyed (Yes)	Ref			Ref			Ref		
No	1.056	1.056	1.057	0.932	0.931	0.933	0.892	0.892	0.893
Travel time to the nearest medical facility									
(<5 minutes)	Ref			Ref			Ref		
5-30 minutes	1.022	1.021	1.023	0.947	0.946	0.948	1.057	1.057	1.058

≥30 minutes	0.972	0.971	0.972	0.991	0.990	0.992	1.032	1.031	1.032

Notes: CHE, catastrophic health expenditure. PCE, per capita household consumption expenditure. UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NCMS, New Rural Cooperative Medical Scheme; Others, government healthcare, private medical insurance and so on. OR, odds ratio. CI, confidence interval.

Table 4. Association of physical and mental multimorbidity with total health expenditure and out-of-pocket expenditures for outpatient and inpatient care

Variable (reference)	OOPE for outpatient care			OOPE for inpatient care			Total health expenditure		
	Coefficient	95% CI		Coefficient	95% CI		Coefficient	95% CI	
No. of chronic diseases									
(Single physical disease)	Ref			Ref			Ref		
Physical multimorbidity	0.322	-0.042	0.686	0.754	0.439	1.069	0.426	0.146	0.706
Physical-mental multimorbidity	0.943	0.578	1.308	0.969	0.656	1.283	0.903	0.600	1.207
Year (2011)	Ref			Ref			Ref		
2015	0.799	0.537	1.061	0.858	0.632	1.084	0.929	0.730	1.127
Gender (Male)	Ref			Ref			Ref		
Female	0.078	-0.163	0.320	-0.016	-0.239	0.208	0.006	-0.190	0.202
Age, years (45-55)	Ref			Ref			Ref		
55-65	0.186	-0.120	0.493	0.205	-0.101	0.511	0.205	-0.053	0.464
65-75	0.231	-0.159	0.620	0.531	0.165	0.896	0.495	0.193	0.798
≥75	0.173	-0.326	0.673	0.567	0.064	1.071	0.541	0.186	0.895
Marital status (Married and partnered)	Ref			Ref			Ref		
Unmarried and others	-0.240	-0.618	0.139	-0.346	-0.679	-0.013	-0.194	-0.491	0.102
Education (Primary school and below)	Ref			Ref			Ref		
Secondary school	0.093	-0.266	0.452	-0.130	-0.412	0.151	0.123	-0.145	0.390
College and above	0.057	-0.355	0.468	-0.134	-0.586	0.319	-0.002	-0.323	0.320
Residence status (Urban)	Ref			Ref			Ref		
Rural	0.120	-0.191	0.431	0.245	-0.025	0.516	0.124	-0.124	0.371
Region (East)	Ref			Ref			Ref		
Central	0.431	0.096	0.767	-0.088	-0.379	0.203	0.226	-0.035	0.488
West	-0.021	-0.350	0.309	0.202	-0.147	0.551	0.017	-0.220	0.254
PCE, quartile (Q1 (deprived))	Ref			Ref			Ref		
Q2	0.325	-0.066	0.716	0.365	0.007	0.723	0.293	-0.011	0.598
Q3	0.391	0.053	0.729	0.826	0.490	1.162	0.497	0.224	0.769
Q4 (affluent)	1.071	0.719	1.423	1.687	1.377	1.997	1.242	0.962	1.523
Health insurance (None)	Ref			Ref			Ref		
UEBMI	0.222	-0.380	0.824	0.145	-0.401	0.692	0.499	0.055	0.943
URBMI	0.187	-0.349	0.724	0.315	-0.239	0.868	0.395	-0.048	0.839
NCMS	0.580	0.149	1.011	0.114	-0.237	0.464	0.468	0.125	0.810
Others	1.918	0.639	3.196	-0.232	-0.944	0.481	1.203	0.233	2.173
Medical facility in village/community									
surveyed (Yes)	Ref			Ref			Ref		
No	-0.078	-0.392	0.236	-0.289	-0.569	-0.009	-0.123	-0.372	0.126
Travel time to the nearest medical facility									
(<5 minutes)	Ref			Ref			Ref		
5-30 minutes	-0.064	-0.454	0.327	-0.011	-0.384	0.362	-0.079	-0.393	0.236

≥30 minutes	0.074	-0.341	0.489	0.192	-0.225	0.610	0.040	-0.291	0.372

Notes: OOPE, out-of-pocket expenditure; PCE, per capita household consumption expenditure. UEBMI, Urban Employee Basic Medical Insurance; URBMI, Urban Resident Basic Medical Insurance; NCMS, New Rural Cooperative Medical Scheme; Others, government healthcare, private medical insurance and so on. CI, confidence interval.

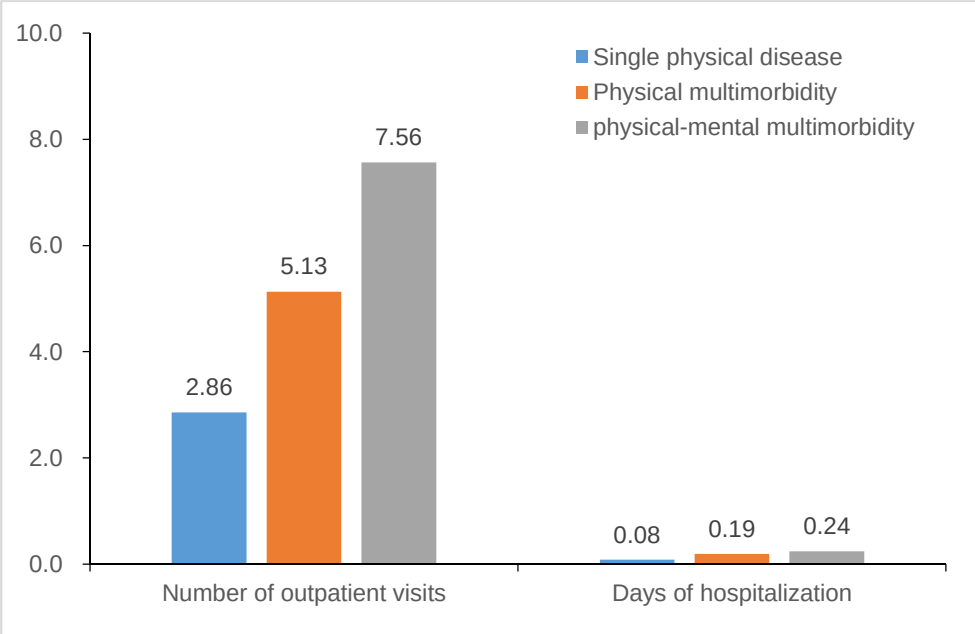

Figure 1. Frequency of outpatient care and stays in hospital by physical and mental disorder, 2011-15.