

Original Paper

Association of Catastrophic Health Expenditure With the Risk of Depression in Chinese Adults: Population-Based Cohort Study

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Abstract

Background: Depression is one of the most common mental illnesses, and it may have a lasting effect on one's whole life. As a form of financial hardship, catastrophic health expenditure (CHE) may be associated with depression. However, current evidence about the relationship between CHE and the risk of depression is insufficient.

Objective: This study aimed to explore the relationship between CHE and the risk of depression among Chinese adults.

Methods: In this study, we used 3 waves of the China Family Panel Studies (CFPS) from 2012, 2016, and 2018. The CFPS are a nationally representative study covering 25 of 31 provinces in Chinese mainland and representing nearly 94.5% of the total population. We selected eligible household heads as participants, divided them into 2 groups by CHE events at baseline (exposed group: with CHE; unexposed group: without CHE), and followed them up. Households with CHE were defined as having out-of-pocket medical expenditures exceeding 40% of the total household nonfood expenditure, and people with depression were identified by the 8-item Centre for Epidemiological Studies Depression Scale (CES-D). We first described the baseline characteristics and used logistical regression to estimate their effects on CHE events. Then, we used Cox proportional hazard models to estimate adjusted hazard ratios and 95% CIs of depression among participants with CHE compared with those without CHE. Finally, we analyzed the subgroup difference in the association between CHE and depression.

Results: Of a total of 13,315 households, 9629 were eligible for analysis. Among them, 6824 (70.9%) were men. The mean age was 50.15 (SD 12.84) years. Only 987 (10.3%) participants had no medical insurance. The prevalence of CHE at baseline was 12.9% (1393/9629). Participants with a higher family economic level (adjusted odds ratio [aOR] 1.15, 95% CI 1.02-1.31) and with the highest socioeconomic development level (aOR 1.18, 95% CI 1.04-1.34) had a higher prevalence of CHE than reference groups. During a median of 71 (IQR 69-72) person-months of follow-up, the depression incidence of participants with CHE (1.41 per 1000 person-months) was higher than those without CHE (0.73 per 1000 person-months). Multivariable models revealed that the adjusted hazard ratio for the incidence of depression in participants with CHE was 1.33 (95% CI 1.08-1.64), and this association appeared to be greater in participants without outpatient services (for interaction, $P=.048$).

Conclusions: CHE was significantly associated with increased risk of depression among Chinese adults. Concentrated work should be done to monitor CHE, and more efforts to ensure financial protection need to be made to prevent depression, especially for people with high health care needs.

KEYWORDS

catastrophic health expenditure; depression; universal health coverage; economic burden; socioeconomic status

Introduction

There is a strong bidirectional linkage between health and poverty. To cut off this linkage, the United Nation's Sustainable Development Goals include target 3.8, which aims to achieve universal health coverage (UHC) by 2030 [1]. UHC means that all people can receive the health services they need without experiencing financial hardship [1]. According to the World Health Organization, globally in 2017, almost 1.4 billion people experienced financial hardship due to out-of-pocket (OOP) health payments, among whom nearly 1 billion people were pushed into extreme poverty [2]. Therefore, there is still a long way to go to achieve UHC goals by 2030 considering the additional impact of COVID-19.

One of the 2 essential parts of UHC is providing financial protection for people to pay for health services [3], and the government of China has made great progress on this front. For example, as early as 2009, China reformed a series of health care reforms including three national basic medical insurance programs: (1) Urban Employee Basic Medical Insurance (UEBMI) designed for employed urban residents; (2) the Urban Resident Basic Medical Insurance (URBMI) covering the unemployed, retired, older adults, students, and children in urban areas; and (3) the New Rural Cooperative Medical Scheme (NRCMS) for rural residents [4]. Currently, China's national basic insurance programs cover over 1.35 billion people, about 97% of the total population [5]. Additionally, to eliminate poverty, the Decision on Winning the Battle Against Poverty policy proposed by China in 2015 achieved substantial results in education, primary medical care, and the basic living needs of people living in poverty. In fact, in 2020, the government of China announced that all low-income counties in China had been lifted out of poverty [6]. Benefitting from policies and measures on financial protection of health, the incidence of catastrophic health expenditure (CHE) in China declined from 14.7% in 2010 to 8.7% in 2018 [7]. However, there are still a few people encountering financial hardship, and the impact on mental and physical health caused by CHE is still worth studying.

Depression is a prevalent mental illness globally that contributes to the global burden of diseases as the leading mental cause of mortality for all ages [8]. Once depression appears, it can have a lasting and profound influence on one's whole life. The direct outcome of depression is a poor quality of life [9]. A study conducted on patients with schizophrenia indicated that depression has a strong negative effect on all 8 domains of subjective quality of life [10]. Furthermore, a meta-analysis showed that compared to controls, patients with depression had significant moderate cognitive deficits in executive function, memory, and attention (Cohen *d* effect sizes ranging from -0.34

to -0.65) [11]. Moreover, depression is a negative factor in cardiovascular disease (CVD) incidence, severity, and outcomes [12]. Rajan et al [13] found that depression was associated with CVD incidence (hazard ratio [HR] 1.14, 95% CI 1.05-1.24) and myocardial infarction (HR 1.14, 95% CI 1.05-1.24). Meng et al [14] also found that depression was associated with a higher risk of CVD mortality (HR 1.22, 95% CI 1.04-1.44). Therefore, the prevention and management of depression is a crucial and urgent public health issue.

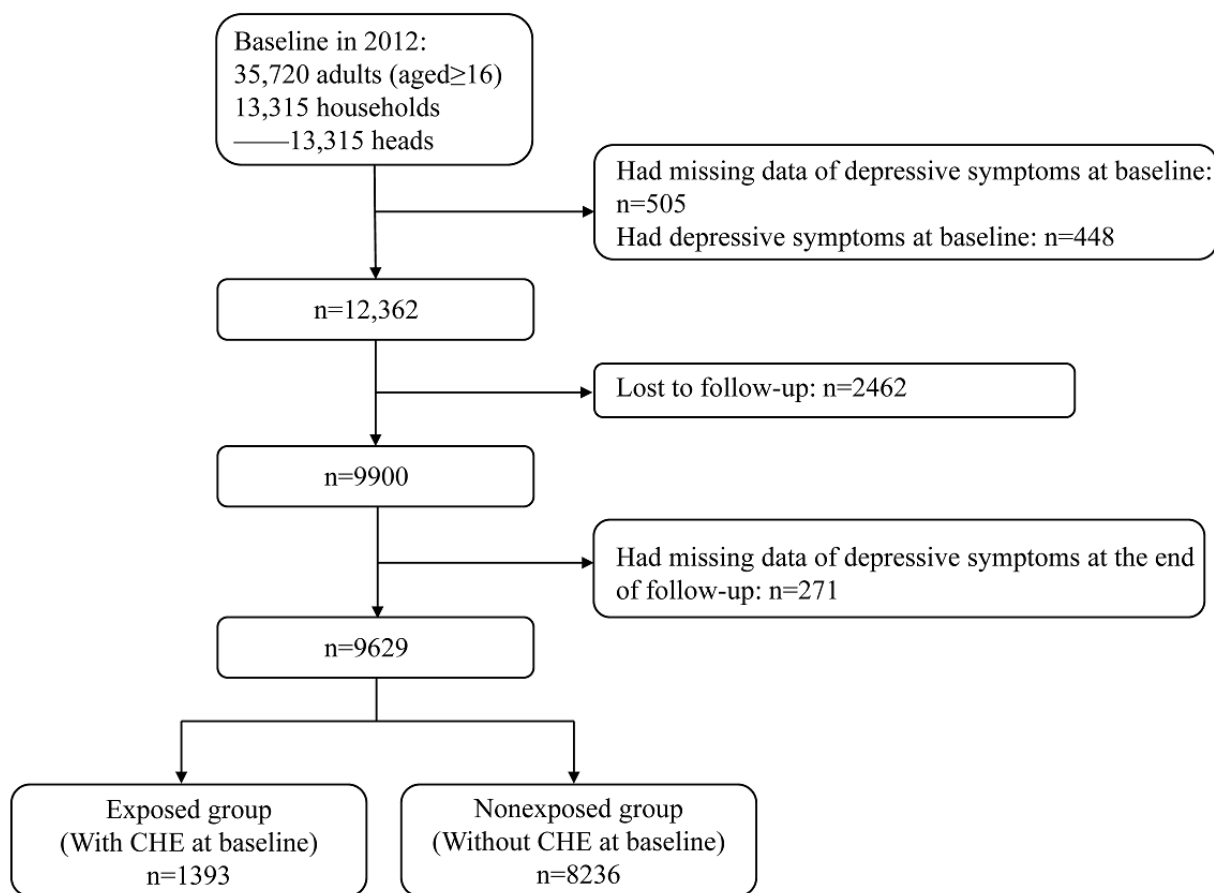
A series of social, psychological, and biological factors and their complex interactions can play a role in depression occurrence [15,16]. Some study results posit that lower social support, a lower socioeconomic position, and economic difficulties are associated with a higher risk of depression [17,18], and the association is stronger between financial hardship and depression than other socioeconomic variables [19]. CHE, in theory, may have an impact on the mental health of family members because of reduced necessary expenditures. Nevertheless, current studies mostly focus on the likelihood of CHE events among people with depression, not the impact of CHE on depression occurrence [20,21]. In this study, we used 3 waves (2012, 2016, and 2018) of nationally representative data from the China Family Panel Studies (CFPS) to analyze the association of CHE with the risk of depression.

Methods

Study Design and Participants

Data in this study were obtained from CFPS, which is almost a nationally representative longitudinal study covering 25 of 31 provinces/municipalities in Chinese mainland (not including Xinjiang, Tibet, Inner Mongolia, Ningxia autonomous region, and Qinghai and Hainan provinces), representing nearly 94.5% of the total population in the Chinese mainland [22]. The CFPS were implemented by the Institute of Social Science Survey of Peking University to collect individual-, household-, and community-level data every 2 years. A baseline survey was conducted in 2010, and follow-up data from 2012, 2014, 2016, and 2018 were available for download from the official CFPS website [23].

As the information on depression in some of the CFPS waves was deficient, we used data from 2012, 2016, and 2018. The survey in 2012 included 35,720 adults (aged ≥ 16 years) and 13,315 households with valid interview responses. Individuals who had missing data at baseline ($n=505$), had depression at baseline ($n=448$), were lost to follow-up ($n=2462$), and had missing data of depression at the end of follow-up ($n=271$) were excluded. Finally, a total of 9629 households (household heads) were included in this study (Figure 1).

Figure 1. Flowchart of participants selected from China Family Panel Studies (CFPS). CHE: catastrophic health expenditure.

Ethics Approval

The CFPS, which involved human participants, were approved by the Biomedical Ethics Review Committee of Peking University (IRB00001052-14010). All written informed consent was provided by participants aged over 15 years or their parents (for those aged 15 years and under). The participants' personal information and privacy were strictly protected by the CFPS according to the rules set by Peking University's Biomedical Ethics Review Committee.

Measurements of Catastrophic Health Expenditure

The measurement of catastrophic health expenditure (CHE) was based on households, where a household member was defined by marriage, blood, or adoptive relationship, as well as an ongoing economic tie [24]. The head of the household was identified as the key decision-maker when the household faced important matters and decisions. Household OOP health payments were measured as the medical expenditure of all family members excluding reimbursed expenses in the past 12 months. The yearly household food expenditure was estimated as the monthly meal expenses multiplied by 12, and the total household expenditure in the past 12 months was calculated as the sum of monthly daily expenditures (food, daily used commodities and necessities, transportation, etc) multiplied by 12 plus yearly special expenditures (electricity, medical care, clothing, etc).

Households who experienced CHE were defined as those with OOP medical expenditures exceeding 40% of the household's capacity to pay (calculated as total household expenditure minus household food expenditure) [25]. CHE prevalence at baseline was measured as the percentage of the number of household heads incurring CHE to total participants. The formula was:

$$CHE \text{ prevalence} = \left(\frac{1}{N} \sum_i^N CHE_i \right) \times 100\%$$

where N is the total number of participants, and CHE_i is 1 when the i_{th} household incurred CHE and 0 otherwise.

Measurements of Depression

Depression was measured by the 8-item Center for Epidemiological Studies Depression Scale (CES-D), which is a shortened version of the original 20-item CES-D including 8 depressive symptoms (Table S1 in [Multimedia Appendix 1](#)). CES-D was not designed as a diagnostic tool but is widely used to identify individuals at high risk of depression in general populations and various subpopulations [26]. The score of each item in the 20-item CES-D ranges from 0 to 3 according to the frequency response of depressive symptoms in the past week, with 0 indicating rarely or none of the time (<1 day), 1 indicating some or a little of the time (1-2 days), 2 indicating occasionally or a moderate amount of time (3-4 days), and 3 indicating most or all of the time (5-7 days) [26]. The commonly used 8-item

CES-D asked respondents whether they experienced any of the 8 depressive symptoms “most of time during the last week” [27], which was scored according to the answer (yes=1; no=0). The 8-item CES-D used in CFPS included the same depressive symptoms but was scored by frequency response. As “most or all of the time” in frequency response is equal to the “yes” answer to “most of time last week,” we transferred the 4-score level of frequency response to the yes/no response [28]. Hence, the score of 8-item CES-D ranged from 0-8, and a total score ≥ 3 was deemed to indicate depression [28]. As the 8-item CES-D cannot diagnose depressive disorders, people with an 8-item CES-D score ≥ 3 in our study were identified as having depressive symptoms [29].

Covariates

Covariates in this study included (1) demographic characteristics: gender (male, female), age group (16-39, 40-49, 50-49, ≥ 60 years), marital status (married/partnered, other), education (no or some formal education, primary school, middle school, high school and above), and insurance (without any insurance, UEBMI, URBMI, NRCMS, other); (2) health-related characteristics: self-reported health (good, medium, poor), chronic diseases (yes, no), BMI (normal, lower, overweight, obese), outpatient services (yes, no), inpatient services (yes, no), current smoking (yes, no), and drinking (yes, no); and (3) socioeconomic characteristics: residence (urban, rural), family economic level (lowest, lower, higher, highest), family size (1-2, 3-4, ≥ 5), and socioeconomic development level (lowest, lower, higher, highest).

The family economic level was classified by the quartiles of household annual income, which was converted into 2012 US dollars based on purchasing power parities published by the World Bank [30] (lowest: $< \$4775.56$, lower: $\$4775.56$ to $< \$9831.46$, higher: $\$9831.46$ to $< \$17173.60$, highest: $\geq \$17173.60$). Numerous studies have reported that nighttime light intensity is highly associated with socioeconomic development [31,32]. Therefore, the socioeconomic development level in this study was identified by the quartiles of provinces' mean nighttime light intensity in 2012 (lowest: < 0.089 , lower: $0.089-0.31$, higher: $0.32-0.68$, highest: ≥ 0.69), which was obtained from the Harvard Dataverse [33].

Statistical Analyses

Baseline characteristics of the participants were presented as mean (SD) for continuous variables or frequencies and percentages for categorical variables. The Pearson χ^2 test was used to compare distributions of CHE according to different baseline characteristics. A multivariate logistical regression model was used to analyze the determinants of CHE.

We calculated the incidence rates (number of events divided by accumulated person-month) and used the univariate and multivariate Cox proportional hazard models to estimate the HRs and 95% CIs of depression among participants with CHE compared with those without CHE. First, the model adjusted demographic characteristics in multivariate model 1, including gender, age group, marital status, education, and insurance. Next, the model adjusted health-related factors in model 2 based on model 1, including self-reported health, chronic diseases, BMI, outpatient services, inpatient services, current smoking, and current drinking. Finally, the model adjusted socioeconomic factors in model 3 based on model 2, including residence, family economic level, family size, and socioeconomic development level.

To examine the robustness of our findings, we conducted 3 sensitivity analyses. First, we defined households with CHE as those having OOP medical expenditure exceeding 25% of the total household expenditure according to the World Bank. [25] Second, we transferred the categorical variables of age group and family economic level into continuous variables and conducted the same analysis in the final model. Third, we changed the variable nighttime light intensity into the gross regional product (GRP, divided into 4 groups based on the quartiles of 2012 per capita GRP [34]) to indicate the socioeconomic development level in the final model.

Finally, the analysis was stratified by gender, age group, insurance, chronic diseases, self-reported health, outpatient services, inpatient services, residence, socioeconomic development level, and family economic level, and a multiplicative interaction term was included in the final model with the stratification variable removed for subgroup analysis.

All data were analyzed in R software (version 4.2.1; R Foundation for Statistical Computing). A 2-sided *P* value $< .05$ was considered to be significant.

Results

Baseline Characteristics

A total of 9629 participants were enrolled in this study, of which 6824 (70.9%) were male. The mean age was 50.15 (SD 12.84) years. Among the participants, 89.5% (8622/9629) were married or partnered. Only 987 (10.3%) participants had no medical insurance, and 1341 (13.9%), 603 (6.3%), and 6317 (65.6%) participants had UEBMI, URBMI, and NRCMS, respectively (Table 1).

Table 1. Distribution of CHE^a by baseline characteristics.

Characteristics	Total (N=9629)	Nonexposed group ^b (n=8236), n (%)	Exposed group ^c (n=1393), n (%)	Chi-square (<i>df</i>)	<i>P</i> value
Demographic characteristics					
Gender					
				3.6 (1)	.06
Male	6824	5867 (86)	957 (14)		
Female	2805	2369 (84.5)	436 (15.5)		
Age group (years)					
				346.3 (3)	<.001
16-39	1931	1753 (90.8)	178 (9.2)		
40-49	3016	2750 (91.2)	266 (8.8)		
50-59	2320	1969 (84.9)	351 (15.1)		
≥60	2362	1764 (74.7)	598 (25.3)		
Marital status					
				9.1 (1)	.003
Married/partnered	8622	7407 (85.9)	1215 (14.1)		
Other	1007	829 (82.3)	178 (17.7)		
Education					
				97.3 (3)	<.001
No or some formal education	2506	2005 (80)	501 (20)		
Primary school	2322	1980 (85.3)	342 (14.7)		
Middle school	2789	2475 (88.7)	314 (11.3)		
High school and above	2012	1776 (88.3)	236 (11.7)		
Insurance					
				5.5 (4)	.24
None	987	856 (86.7)	131 (13.3)		
UEBMI ^d	1341	1169 (87.2)	172 (12.8)		
URBMI ^e	603	511 (84.7)	92 (15.3)		
NRCMS ^f	6317	5378 (85.1)	939 (14.9)		
Other	381	322 (84.5)	59 (15.5)		
Health-related characteristics					
Self-reported health					
				245.5 (2)	<.001
Good	5874	5241 (89.2)	633 (10.8)		
Medium	2001	1692 (84.6)	309 (15.4)		
Poor	1754	1303 (74.3)	451 (25.7)		
Currently smoking					
				12.6 (1)	<.001
No	5355	4519 (84.4)	836 (15.6)		
Yes	4274	3717 (87)	557 (13)		
Drinking					
				16.4 (1)	<.001
No	7282	6168 (84.7)	1114 (15.3)		
Yes	2347	2068 (88.1)	279 (11.9)		
Chronic diseases					
				104 (1)	<.001
No	8268	7195 (87)	1073 (13)		
Yes	1361	1041 (76.5)	320 (23.5)		
BMI					
				25.8 (3)	<.001
Normal	5596	4776 (85.3)	820 (14.7)		
Lower	711	569 (80)	142 (20)		

Characteristics	Total (N=9629)	Nonexposed group ^b (n=8236), n (%)	Exposed group ^c (n=1393), n (%)	Chi-square (<i>df</i>)	<i>P</i> value
Overweight	2658	2301 (86.6)	357 (13.4)		
Obese	664	590 (88.9)	74 (11.1)		
Outpatient services				101.8 (1)	<.001
No	7577	6624 (87.4)	953 (12.6)		
Yes	2052	1612 (78.6)	440 (21.4)		
Inpatient services				164.4 (1)	<.001
No	8747	7644 (87.4)	1103 (12.6)		
Yes	882	592 (67.1)	290 (32.9)		
Socioeconomic characteristics					
Residence				11.7 (1)	<.001
Urban	4315	3750 (86.9)	565 (13.1)		
Rural	5314	4486 (84.4)	828 (15.6)		
Family economic level				55.8 (3)	<.001
Lowest	2988	2439 (81.6)	549 (18.4)		
Lower	2336	2021 (86.5)	315 (13.5)		
Higher	2366	2084 (88.1)	282 (11.9)		
Highest	1939	1692 (87.3)	247 (12.7)		
Family size				151.5 (2)	<.001
1-2	2158	1677 (77.7)	481 (22.3)		
3-4	4302	3833 (89.1)	469 (10.9)		
≥5	3169	2726 (86)	443 (14)		
Socioeconomic development level				6.4 (3)	.09
Lowest	2491	2158 (86.6)	333 (13.4)		
Lower	1492	1258 (84.3)	234 (15.7)		
Higher	3726	3199 (85.9)	527 (14.1)		
Highest	1920	1621 (84.4)	299 (15.6)		

^aCHE: catastrophic health expenditure.

^bPeople without CHE.

^cPeople with CHE.

^dUEBMI: Urban Employee Basic Medical Insurance.

^eURBMI: Urban Resident Basic Medical Insurance.

^fNRCMS: New Rural Cooperative Medical Scheme.

CHE Prevalence

At baseline, the prevalence of CHE was 12.9% (1393/9629) among the participants. Except for gender, insurance, and socioeconomic development level, the distribution of baseline characteristics was significantly different between households with CHE and those without CHE (Table 1). The logistical regression analysis revealed that participants with poor (adjusted odds ratio [aOR] 1.64, 95% CI 1.39-1.94) and medium self-reported health (aOR 1.17, 95% CI 1-1.37), chronic diseases (aOR 1.30, 95% CI 1.11-1.52), outpatient services (aOR 1.16, 95% CI 1-1.35) and inpatient services (aOR 2.40, 95% CI 2.03-2.84), rural residence (aOR 1.21, 95% CI 1.05-1.39), family size ≥5 people (aOR 1.22, 95% CI 1.09-1.36), higher family

economic level (aOR 1.15, 95% CI 1.02-1.31), and the highest socioeconomic development level (aOR 1.18, 95% CI 1.04-1.34) had a higher prevalence of CHE than reference groups (Table S2 in Multimedia Appendix 1).

Risk of Depression

During a median of 71 (interquartile range: 69-72) person-months of follow-up, 532 (5.53%) of 9629 participants developed depression, of which 403 (75.75%) cases had no CHE and 129 (24.25%) cases had CHE. The incidence rate of depression among participants without and with CHE was 0.73 and 1.41 per 1000 person-months, respectively (Table 2). In the unadjusted analysis, participants who had CHE at baseline were associated with a 99% higher risk of depression (crude HR 1.99,

95% CI 1.63-2.42; [Table 2](#)). All multivariable-adjusted analyses showed a significant association of CHE with the risk of depression (Table S3 in [Multimedia Appendix 1](#)). In the fully adjusted model, participants with CHE had a 33% increased risk of developing depression compared to those without CHE (adjusted HR [aHR] 1.33, 95% CI 1.08-1.64; [Table 2](#)).

In the sensitivity analyses, the association between CHE and risk of depression was stable when we (1) defined CHE as OOP medical expenditure exceeding 25% of the total household expenditure, (2) transferred the categorical variables age group and family economic level to continuous variables, and (3) changed the variable nightlight time intensity into GRP to indicate socioeconomic development level in the final model (Table S4 in [Multimedia Appendix 1](#)).

Table 2. Association of CHE^a with risk of depression in the univariate and multivariate Cox proportional hazard models.

Characteristics	Outcome (N=532), n (%)	Incidence (per 1000 person- months)	Univariate model		Multivariate model ^b	
			cHR ^c (95% CI)	P value	aHR ^d (95% CI)	P value
CHE						
Without	403 (75.8)	0.73	Reference		Reference	
With	129 (24.2)	1.41	1.99 (1.63-2.42)	<.001	1.33 (1.08-1.64)	.008
Gender						
Male	318 (59.8)	0.70	Reference		Reference	
Female	214 (40.2)	1.15	1.69 (1.42-2.01)	<.001	1.51 (1.19-1.91)	.001
Age group (years)						
16-39	50 (9.4)	0.39	Reference		Reference	
40-49	144 (27.1)	0.71	2.39 (1.93-2.97)	<.001	1.61 (1.27-2.06)	<.001
50-59	154 (28.9)	0.99	0.84 (0.69-1.02)	.08	0.78 (0.64-0.96)	.02
≥60	184 (34.6)	1.20	1.03 (0.87-1.22)	.70	0.97 (0.82-1.15)	.74
Marital status						
Married/partnered	433 (81.4)	0.75	Reference		Reference	
Other	99 (18.6)	1.54	2.22 (1.78-2.76)	<.001	1.34 (1.05-1.70)	.02
Education						
No or some formal education	255 (47.9)	1.56	Reference		Reference	
Primary school	121 (22.7)	0.78	0.36 (0.29-0.44)	<.001	0.63 (0.50-0.80)	<.001
Middle school	100 (18.8)	0.53	1.27 (1.04-1.54)	.02	1.18 (0.96-1.44)	.12
High school and above	56 (10.5)	0.42	0.95 (0.79-1.15)	.61	1.01 (0.83-1.22)	.95
Insurance						
None	71 (13.3)	1.11	Reference		Reference	
UEBMI ^e	35 (6.6)	0.39	0.35 (0.23-0.52)	<.001	0.52 (0.34-0.79)	.002
URBMI ^f	23 (4.3)	0.57	0.51 (0.32-0.81)	.004	0.53 (0.33-0.85)	.009
NRCMS ^g	394 (74.1)	0.93	0.82 (0.64-1.06)	.13	0.68 (0.52-0.89)	.004
Other	9 (1.7)	0.35	0.30 (0.15-0.61)	.001	0.43 (0.21-0.88)	.02
Self-reported health						
Good	201 (37.8)	0.51	Reference		Reference	
Medium	110 (20.7)	0.83	1.61 (1.28-2.03)	<.001	1.32 (1.04-1.68)	.02
Poor	221 (41.5)	1.93	3.89 (3.21-4.71)	<.001	2.10 (1.67-2.64)	<.001
Currently smoking						
No	314 (59.0)	0.88	Reference		Reference	
Yes	218 (41.0)	0.77	0.86 (0.72-1.02)	.08	1.14 (0.92-1.42)	.24
Drinking						
No	435 (81.8)	0.90	Reference		Reference	
Yes	97 (18.2)	0.62	0.67 (0.54-0.84)	.001	0.88 (0.69-1.11)	.29
Chronic diseases						
No	419 (78.8)	0.76	Reference		Reference	
Yes	113 (21.2)	1.25	1.62 (1.31-1.99)	<.001	1.17 (0.94-1.46)	.15

Characteristics	Outcome (N=532), n (%)	Incidence (per 1000 person- months)	Univariate model		Multivariate model ^b	
			cHR ^c (95% CI)	P value	aHR ^d (95% CI)	P value
BMI						
Normal	311 (58.5)	0.84	Reference		Reference	
Lower	65 (12.2)	1.41	1.75 (1.34-2.28)	<.001	1.13 (0.86-1.48)	.40
Overweight	118 (22.2)	0.66	0.79 (0.64-0.98)	.03	0.92 (0.74-1.13)	.42
Obese	38 (7.1)	0.85	1.05 (0.75-1.47)	.78	1.13 (0.80-1.58)	.50
Outpatient services						
No	326 (61.3)	0.64	Reference		Reference	
Yes	206 (38.7)	1.52	2.36 (1.98-2.81)	<.001	1.41 (1.16-1.72)	.001
Inpatient services						
No	477 (89.7)	0.82	Reference		Reference	
Yes	55 (10.3)	0.95	1.18 (0.89-1.56)	.24	0.70 (0.52-0.94)	.02
Residence						
Urban	173 (32.5)	0.61	Reference		Reference	
Rural	359 (67.5)	1.01	1.65 (1.37-1.98)	<.001	1.23 (1-1.52)	.06
Family economic level						
Lowest	240 (45.1)	1.21	Reference		Reference	
Lower	109 (20.5)	0.70	0.55 (0.46-0.67)	<.001	0.75 (0.61-0.93)	.008
Higher	116 (21.8)	0.74	1.11 (0.92-1.34)	.28	1.03 (0.85-1.24)	.79
Highest	67 (12.6)	0.52	0.79 (0.66-0.96)	.02	0.83 (0.69-1)	.049
Family size						
1-2	165 (31)	1.17	Reference		Reference	
3-4	200 (37.6)	0.69	0.72 (0.62-0.84)	<.001	0.96 (0.81-1.15)	.69
≥5	167 (31.4)	0.79	1.34 (1.16-1.55)	<.001	1.02 (0.88-1.19)	.78
Socioeconomic development level						
Lowest	174 (32.7)	1.05	Reference		Reference	
Lower	92 (17.3)	0.93	0.69 (0.57-0.83)	.001	1.01 (0.78-1.32)	.92
Higher	186 (35.0)	0.75	0.92 (0.77-1.11)	.39	0.86 (0.69-1.06)	.16
Highest	80 (15.0)	0.63	1.01 (0.84-1.20)	.94	0.73 (0.55-0.97)	.03

^aCHE: catastrophic health expenditure.

^bAdjusted for demographic characteristics (gender, age group, education, marital status, and insurance), health-related characteristics (self-reported health, smoking status, drinking, chronic disease, BMI, and outpatient and inpatient services), and socioeconomic characteristics (residence, family economic level, family size, and socioeconomic development level).

^ccHR: crude hazard ratio.

^daHR: adjusted hazard ratio.

^eUEBMI: Urban Employee Basic Medical Insurance.

^fURBBI: Urban Resident Basic Medical Insurance.

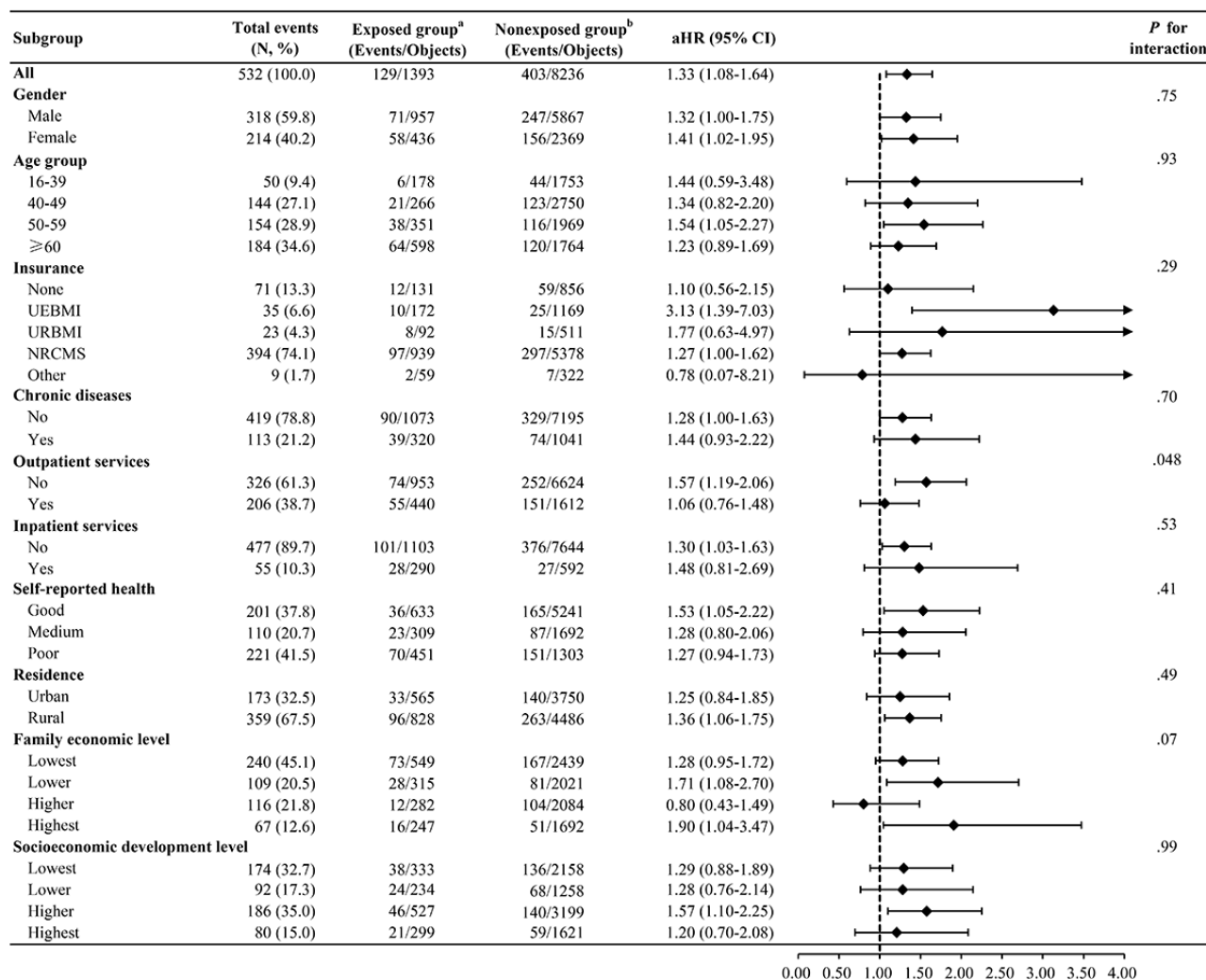
^gNRCMS: New Rural Cooperative Medical Scheme.

Subgroup Analyses

In the subgroup analyses, the association of CHE with the risk of depression did not appear to be modified by most selected baseline characteristics, such as gender, age group, insurance, or chronic diseases (Figure 2). However, the association between

CHE and the risk of depression was found to be somewhat greater among participants without outpatient services (for interaction, $P=.048$). The risk of depression was higher among participants with CHE who did not have outpatient services (aHR 1.57, 95% CI 1.10-2.25) than those who had outpatient services (aHR 1.06, 95% CI 0.76-1.48).

Figure 2. Association of catastrophic health expenditure (CHE) with risk of depression in univariate and multivariate Cox proportional hazard models. Superscripted a refers to people with CHE. Superscripted b refers to people without CHE. aHR: adjusted hazard ratio; NRCMS: New Rural Cooperative Medical Scheme; UEBMI: Urban Employee Basic Medical Insurance; URBMI: Urban Resident Basic Medical Insurance.



Discussion

CHE can introduce great financial pressure to a household, as household members may have to borrow money, use savings, and even sell assets [35], which may lead to a longtime negative effect on their mental health [36]. To our knowledge, this is the first cohort study on the association between CHE and the risk of depression. We found that health-related characteristics (chronic diseases, self-reported health, and outpatient and inpatient services) and socioeconomic characteristics (residence, socioeconomic development level, family size, and family economic level) had an impact on CHE. We also found that prior CHE events were strongly associated with depression experienced by household heads and that there was an interaction between CHE and outpatient services for depression.

Our results revealed that people with chronic diseases, medium and poor self-reported health, outpatient services and inpatient services, rural, family size ≥ 5 people, and the highest socioeconomic development level had a higher prevalence of CHE, and these findings are consistent with those of other studies [7,37]. Poor health directly leads to a higher frequency of accessing health services, further leads to a heavy financial

burden of medical expenditure, and finally, leads to CHE. Nighttime light intensity is an indicator of socioeconomic development, and areas with higher economic growth may have access to diagnostic technology for most illnesses. In addition, people in areas undergoing rapid socioeconomic development may pay more attention to the early detection of diseases and other preventive health care services [38]. Consequently, health-related characteristics and socioeconomic characteristics were the main factors behind CHE.

The results of our study revealed that people with CHE had a 33% higher risk of developing depression (aHR 1.33, 95% CI 1.08-1.64) than people without CHE. Socioeconomic variables, especially financial hardship, have a great influence on depression [39]. As a form of financial hardship, CHE plays a role in depression incidence. Once a household incurred CHE, family members had to take various measures to cope with financial loss, which could take a long time to recover [35]. Given this, household heads had a higher risk of developing depression with CHE than those without CHE under financial pressure.

As CHE could trigger depression, which may further lead to adverse outcomes [40,41], it is crucial to eliminate CHE to

prevent depression. The first step to eliminating CHE is based on reducing OOP health expenditures. Because poor health is associated with an increased need and use of outpatient and inpatient care, and this negative correlation can be intensified by the number of chronic diseases [37], our results suggest that relevant departments should continue to expand health promotion, especially for chronic diseases. Additionally, governments should provide sufficient and targeted financial protection, including medical insurance and poverty subsidies, to reduce OOP payments and mitigate impoverishment caused by poor health. Most studies on CHE are interested in subpopulations that have specialized diseases like cancers, HIV, and tuberculosis [42-44]. The common features of these diseases are long duration, which may even coexist with people and cause a higher risk of CHE. To decrease individual OOP health expenditure, inclined policies and measures should be introduced for these diseases. For example, to relieve the financial burden faced by people living with chronic diseases, China launched catastrophic medical insurance (critical illness insurance) in 2012 and implemented it nationwide in 2016 after city-based testing, with the aim of reimbursing patients whose OOP health expenditure exceeded a predetermined basic medical insurance level [45]. In addition, for eligible people facing unaffordable medical expenses, China provided medical assistance and even offered treatment for free or at a reduced price for some priority diseases [46]. Of course, these policies are mostly aimed at financially vulnerable people. However, our study found that people with a higher family economic level and the highest socioeconomic development level were more likely to occur CHE, which may be explained by the concentrated distribution and utilization of health services. [47] In view of this, more financial protection policies should be implemented for the whole population regardless of their economic capacity. Additionally, as the current health care delivery in China is still fragmented and treatment-based [48], with increasing incidence of age-related diseases, integrated establishment and improvement of primary health services should be intensified in health-related policies.

To cut off the linkage between CHE and depression, the second point is to halt the progression to depression. As the evidence shows in studies on financial hardship and depression, not all people experiencing financial hardship will develop depression [39]. These differing responses to CHE may be explained by

various socioeconomic and psychological variables in the stress process model, such as social support, self-esteem, personal agency, and personal ability to manage difficulties [39,49,50]. Therefore, measures to prevent and regulate depression should be extended widely. Additionally, timely financial assistance should be implemented for vulnerable populations, such as people with chronic diseases and households under the minimum living guarantee.

In this study, we found that the risk of depression was higher among participants with CHE who did not have outpatient services (aHR 1.57, 95% CI 1.10-2.25) than those who had outpatient services (aHR 1.06, 95% CI 0.76-1.48). In CFPS, the variable "outpatient services" was measured by whether participants had used outpatient services in the past 2 weeks when they felt uncomfortable. Those without outpatient services included people who did not feel uncomfortable and who felt uncomfortable but did not use health services. The latter group may have a lower socioeconomic status. Moreover, heads of households with lower social support, a lower socioeconomic position, and economic difficulties were more likely to experience depression due to life pressures [17,18]. Consequently, not accessing outpatient services intensified the association between CHE and the risk of depression.

There are several limitations to our study. First, because the 8-item CES-D is not equal to clinical diagnosis, our study could only estimate the association between CHE and the risk of depressive symptoms, which calls for future research on CHE and depressive disorders. Second, due to the limitation of the original data, households with CHE did not include those facing extreme poverty who could not seek health services and whose household medical expenditure was zero. Third, expenditure data for calculating CHE were mainly based on the participants' memory, which may be prone to recall bias.

In conclusion, people with poor health and a higher socioeconomic position had a higher prevalence of CHE and CHE was significantly associated with a higher risk of depression. To prevent depression induced by CHE, concentrated work should be made to monitor CHE, and more efforts to ensure financial protection need to be introduced and strengthened, especially for people with higher health care needs.

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Data Availability

Data from all are available to download from the official China Family Panel Studies (CFPS) website.

Authors' Contributions

JL conceptualized and designed the study. YW carried out the literature search, data analysis, and interpretation; compiled the tables and figures; and drafted the manuscript. WL, ML, and JL wrote, reviewed, and edited the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Additional tables.

[\[DOCX File , 41 KB-Multimedia Appendix 1\]](#)

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Abbreviations

- aHR:** adjusted hazard ratio
- aOR:** adjusted odds ratio
- CES-D:** Center for Epidemiological Studies Depression Scale
- CFPS:** China Family Panel Studies
- CHE:** catastrophic health expenditure
- CVD:** cardiovascular disease
- GRP:** gross regional product
- HR:** hazard ratio
- NRCMS:** New Rural Cooperative Medical Scheme
- OOP:** out-of-pocket
- UEBMI:** Urban Employee Basic Medical Insurance
- UHC:** universal health coverage
- URBMI:** Urban Resident Basic Medical Insurance

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