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Effects of falls on self-rated health and anxiety in Chinese older persons with chronic multimorbidity : moderating role of psychological resilience

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Abstract

Introduction This study investigated the effects of falls on self-rated health and anxiety symptoms and the moderating role of psychological resilience in Chinese older persons with chronic multimorbidity.

Methods Data were taken from the 2018 Chinese Longitudinal Healthy Longevity Survey (CLHLS). We used a linear regression model to evaluate the associations among falls and self-rated health and anxiety symptoms, the moderating role of psychological resilience was verified by moderation analysis, and we also used a replacement model to test robustness. Finally, the results of the study were further verified via heterogeneity analysis through subgroup regression.

Results A total of 2933 people aged 60 years or older with chronic multimorbidity were included in our study. The linear regression results revealed that falls were significantly negatively correlated with the self-rated health symptoms of older Chinese people with chronic multimorbidity ($\beta = -0.1703$, $p < 0.01$) and significantly positively correlated with anxiety symptoms ($\beta = 0.5590$, $p < 0.01$). Among the moderating effects, we found that psychological resilience played a moderating role between falls and anxiety symptoms ($\beta = -0.151$ [-0.217, -0.084], $p < 0.01$). Finally, we found heterogeneity in the study results by sex, residence and number of chronic diseases.

Conclusion Falls are associated with poorer self-rated health and higher anxiety levels among older persons with chronic multimorbidity in China. High levels of psychological resilience have a moderating effect on the development of anxiety symptoms.

Keywords Falls, Anxiety, Psychological resilience, Chinese older persons with chronic multimorbidity

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Introduction

Falls are defined as events in which a person unintentionally falls to the ground, floor, or other lower level, causing them to lose consciousness [1]. Falls have become a significant public health issue with high incidence rates worldwide [2]. Surveys indicate that falls pose a serious threat to the health and safety of older adults, with approximately 68,400 fatal falls occurring each year [1]. Additionally, as a common geriatric syndrome, it is one of the leading causes of injury and death in older people [3]. A study revealed that 27.5% of people over 65 years old had fallen at least once a year, and 10.2% of people over 65 years old reported at least one fall-related injury [4]. In China, falls are also prevalent among elderly individuals, with risk factors such as functional decline, polypharmacy, and chronic diseases increasing with age [5]. Falls not only predispose older adults to physical health impairment issues (e.g., hip fracture) [6] but can also be detrimental to their mental health symptoms. Limb damage, mobility problems and reduced independence due to falls can strongly affect some emotionally vulnerable older adults, increasing their likelihood of developing symptoms of anxiety and fear of falling again [7].

Chronic multimorbidity is defined as the co-presence of two or more chronic diseases within an individual [8]. A recent study revealed that the overall prevalence of chronic multimorbidity is currently as high as 37.2% globally, with more than half of all adults over the age of 60 years suffering from two or more chronic diseases [9]. The interplay of multiple diseases in patients with chronic multimorbidity can easily lead to further declines in physical and cognitive function [10], increasing their susceptibility to falls. In turn, the consequences of falls are even worse for individuals with chronic multimorbidity, thus forming a vicious cycle. Although previous research has predominantly examined the impact of falls on the physical and mental health of elderly individuals [5, 11, 12], investigations into the effects of falls on those with chronic multimorbidity are limited. Therefore, in this study, older persons with chronic multimorbidity were taken as the research objects to further explore the series of impacts on their physical and mental health caused by the emergence of falls.

Self-rated health is a very effective clinical method for measuring overall health, which can reflect the continuity of a person's perceived health [6] and can enable people to visually represent the changes in their own health before and after falls, thus, further research on the relationship between falls and the physical health symptoms of older persons with chronic multimorbidity through self-rated health is important. In addition, anxiety and depression are prevalent psychological disorders among older adults and are key factors affecting mental health. It has been suggested that falls are a potential contributor to anxiety or depression in older adults, but they have not yet been adequately studied [13]. However, in reality, more studies have discussed the association between falls and depression, and most scholars believe that there is a significant interaction between falls and depressive symptoms [12, 14–16] and that the physiological damage caused by falls increases the risk of depression, which is more likely to lead to falling again. Some studies have explored the mechanisms linking falls to depression, including cognitive and motor delays and functional limitations [17, 18]. In contrast, very little research has adequately discussed the impact of fall events on anxiety, which is one of the most common mental health disorders, with a global prevalence of 2.4 −29.8% per year [19, 20]. To date, only one study has specifically examined changes in anxiety symptoms due to falls [21], and its findings suggest that falls predispose older adults to physical and psychological consequences such as limitations in functional ability, fear of falling, and low self-efficacy, which may lead them to suffer from higher levels of anxiety. It is thus clear that the association between falls and anxiety in chronic multimorbid persons is likewise of some research value, however, it has not been widely studied by scholars. Therefore, to fill these gaps, this study focused on a group of older persons with chronic multimorbidity in China, aiming to delve into the impact of the emergence of falls on their self-rated health and anxiety status, with a focus on post-fall interventions, which would be beneficial for the development of post-fall recovery measures for older persons with chronic multimorbidity.

Additionally, in this case, it was further hypothesized that individuals in different mental states may be affected to different degrees after falls. In positive psychology, a very important concept called psychological resilience refers to the process by which a set of abilities and characteristics interact dynamically to enable an individual to adapt well in the face of adversity, trauma, tragedy, threats, or significant sources of stress [22, 23]. In recent years, the study of psychological resilience has emerged as a promising area of discovery and has gained widespread scholarly attention. Psychological resilience, as a universal psychological factor, has the ability to influence all injured or damaged people to some degree [24]. Despite the limited empirical evidence on the use of older people as targets for psychological resilience interventions, research still suggests that intervention can lead to improvements in older people's health [25]. People of advanced age are always faced with various challenges and stressors [26], such as declining health, and the mindset and the way they cope with these challenges become particularly important at this time. The level of psychological resilience has been shown to affect anxiety and depression in older adults, which in turn affects their outlook on life [27]. On the basis of these findings, the

occurrence of falls affects self-rated health and anxiety in older persons with chronic multimorbidity, and it is possible that psychological resilience may play a moderating role in this process, that is, the extent to which falls affect the physical and mental health of older adults varies with the level of psychological resilience.

On the basis of the above discussion, we hypothesized that (a) there is an association between falls and self-rated health in Chinese older persons with chronic multimorbidity ; (b) there is an association between falls and anxiety symptoms in Chinese older persons with chronic multimorbidity; (c) psychological resilience has a specific moderating effect on the path between falls and self-rated health among older persons with chronic multimorbidity; (d) psychological resilience has a specific moderating effect on the path between falls and anxiety symptoms among older persons with chronic multimorbidity (Fig. 1).

Materials and methods

Participants

The data for this study were obtained from the 2018 wave of the Chinese Longitudinal Healthy Longevity Survey (CLHLS). The CLHLS involves a random selection of nearly half of the counties and cities in 22 provinces in China and collects detailed information on the individual behaviors, families, and social environments of seniors aged 60 and above [28]. This dataset is characterized by a large sample size, a long follow-up period, and strong representativeness, offering high reliability and validity. Since information on falls, anxiety, and psychological resilience levels in older adults was rated only in 2018, we conducted a cross-sectional study. In this study, 15,874 samples of raw data were initially obtained, and the inclusion criteria for the study participants were (a) age≥60 years, (b) two or more chronic diseases, (c) complete answers to the relevant items of the "Anxiety Scale" and the assessment of "psychological resilience" in the CLHLS dataset, (d) no other key variables were missing or abnormal. Ultimately, a total of 3,141 individuals were included in the study. The process of sample screening is shown in Fig. 2.

Measurements

Anxiety

In this study, we used the generalized anxiety scale (GAD-7) in the CLHLS to assess anxiety symptoms in older adults with chronic multimorbidity. We assessed the frequency and severity of anxiety symptoms using participants' descriptions of their emotional feelings. The scale consists of seven items, each with four response options. "The scores ranged from 0 to 21. Anxiety scores<5 were classified as no anxiety symptoms, and scores≥5 were classified as anxiety symptoms. The higher the score is, the worse the anxiety. The Cronbach's alpha coefficient of the GAD-7 was 0.91 [29].

Self-rated health

Self-rated health, as a subjective health measure, provides a valuable reflection of an individual's overall health. To better measure another dependent variable in this study, we selected the item "How do you feel about your own health now?" from the CLHLS questionnaire. This item measures the self-rated health status of older persons with chronic multimorbidity. In accordance with the question answer setting, we used SRH as a continuous variable with a range of 1–5, with higher scores reflecting better health symptoms.

Falls

Falls were designated as the independent variable of the study, and for the measurement of falls, a question such as this one from CLHLS was used: "Have you fallen in the past year?" If the respondent answered "yes", a fall was considered to have occurred.
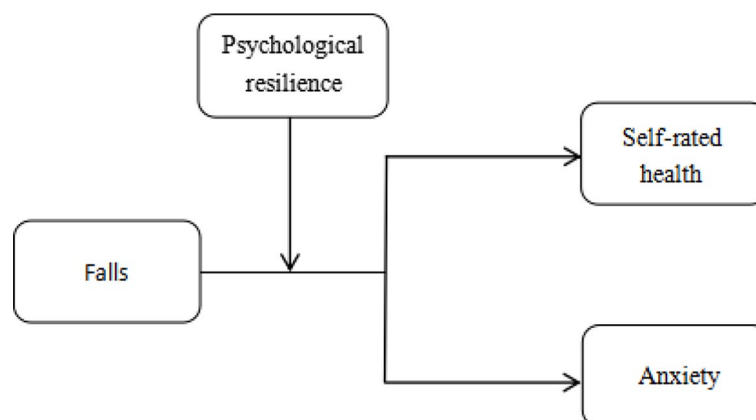

Fig. 1 The moderating effect path hypothesis

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┌─────────────────────────────┐
│  Total Sample in CLHLS 2018 │
│        N=15,874             │
└─────────────────────────────┘
              │            ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
              │ ◄ ─ ─ ─ ─ ─  9,817 participants without    │
              ▼            │      multimorbidity           │
┌─────────────────────────────┐ └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
│  Total Sample in CLHLS 2018 │
│        N=6057              │
└─────────────────────────────┘
              │            ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
              │ ◄ ─ ─ ─ ─ ─  596 participants without Anxiety and │
              ▼            │  self-reported health variables │
┌─────────────────────────────┐ └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
│  Total Sample in CLHLS 2018 │
│        N=5461             │
└─────────────────────────────┘
              │            ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
              │ ◄ ─ ─ ─ ─ ─  367 participants without falls and │
              ▼            │  psychological resilience variables │
┌─────────────────────────────┐ └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
│  Total Sample in CLHLS 2018 │
│        N=5094             │
└─────────────────────────────┘
              │            ┌ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┐
              │ ◄ ─ ─ ─ ─ ─  2,161 participants without other │
              ▼            │    covariates information      │
┌─────────────────────────────┐ └ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ─ ┘
│  Total Sample in CLHLS 2018 │
│        N=2933             │
└─────────────────────────────┘
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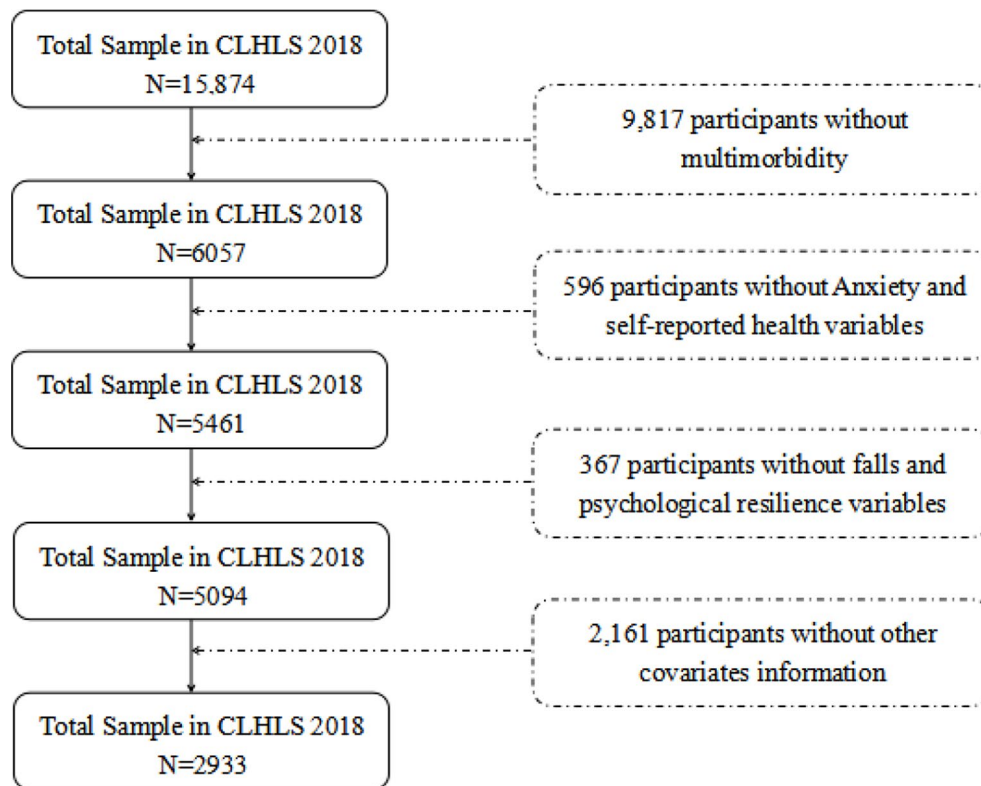
Fig. 2 Sample screening process

Psychological resilience

According to existing research [30], the psychological resilience score needed for this study was specifically measured by five items in the CLHLS: "Are you able to think through whatever comes your way?", "Are you in charge of your own affairs?" "Do you feel that you are getting worse as you get older, and that you have trouble doing things?" "Do you feel nervous and scared?" and "Do you feel lonely?" Each item was rated on a five-point Likert scale. Items one and two were reverse-scored and recoded for analysis, resulting in a total score ranging from 5 to 25. A high or low score predicts a high or low level of psychological resilience. In terms of internal consistency confidence, the acceptable value for the psychological resilience scale was 0.888.

Control variables

This study also considered previous research and selected a range of control variables that are likely to influence anxiety symptoms and changes in self-rated health [18]. These variables encompass three main aspects [18]: socio-demographic characteristics, family socio-economic characteristics, and healthy living conditions. First, socio-demographic characteristics include age, sex, place of residence, and marital status. We reclassified marital status into the following categories on the basis of the answers to the questionnaire: married and

divorced/widowed/unmarried/never married. Second, considering that family socio-economic characteristics, type of residence, and insurance situation may have an impact on the physical and psychological conditions of chronic multimorbid persons after a fall, in this paper, we selected economic status, type of residence, and whether or not they have old-age pensions and medical insurance as the socio-economic characteristics of the family, for which the variable of economic status was measured via the following question: "Which of the following categories does your life belong to when compared in the local area?" is used for measurement. Third, healthy living conditions variables included smoking or drinking alcohol, daily exercise, hours of sleep, depression symptoms and ADLs, for which ADLs were calculated and assigned a total score based on the following variables: bathing, dressing, toilet, indoor activities, self-control, and eating (=6 is unimpaired and assigned a value of "0"). <6 is assigned a value of "1"). Daily exercise was measured by the item "Do you do exercises regularly at present?" from the CLHLS, "Yes" is assigned a value of "1", and "No" is assigned a value of "2". The detailed settings for each variable are provided in Table 1.

Statistical analysis

First, we conducted descriptive analysis by calculating the frequency and percentage of categorical variables, as

Table 1 Coding of variables

Variable	Coding
Anxiety	<5 = 0, ≥ 5 = 1
Levels of anxiety	0~21
Self-rated health	Very poor = 1, Poor = 2, Fair = 3, Good = 4, Very good = 5
Falls	No = 1,Yes = 2
Psychological resilience	5~25
Age	≥ 60
Gender	Male = 1, Female = 2
Marital status	Married = 1, Divorced/Widowed/Never married = 2
Current residence	Urban = 1, Rural = 2
Family economic symptoms	Very rich = 1, Rich = 2, So so = 3, Poor = 4, Very poor = 5
Co-residence	With household member(s) = 1,Alone = 2 In an institution = 3
Pension insurance	Yes = 1,No = 2
Medical insurance	Yes = 1,No = 2
ADL	No impaired = 0, Impaired = 1
Depression symptom	0~30
Smoke	Yes = 1,No = 2
Drink	Yes = 1,No = 2
Exercise	Yes = 1,No = 2
Sleep time	Continuous variable
Chronic diseases	Continuous variable

well as the mean ± standard deviation of continuous variables. Second, we used a linear regression model to test whether there was a correlation between falls and self-rated health and anxiety symptoms in older persons with chronic multimorbidity. In addition, we incorporated a moderated effects model that utilized the multiplication of the independent and moderating variables to take shape an interaction item and added the independent variable X, dependent variable Y, moderating variable W, and interaction item XW to the model to test the presence of moderating effects on psychological resilience. Finally, given that self-rated health and anxiety symptom scores are continuous variables, we performed robustness checks by replacing the model to verify the reliability of the regression results. We also examined heterogeneity by sex, place of residence and number of chronic diseases via group regression analysis. All the statistical analyses were performed using STATA 17.0.

Results

Descriptive statistical analysis

As shown in Table 2, there were 2,933 older persons with chronic multimorbidity in this study. Among them, 41.46% were male. The age distribution was as follows: 14.52% were aged 60–70 years, 33.31% were aged 71–80 years, 29.56% were aged 81–90 years, and 22.61% were aged 90 years or older. Additionally, 46.61% of the population were married. Urban residents made up 52.34% of

the sample, whereas 79.91% lived with family members. 40.13% and 53.02% had pension insurance and medical insurance, respectively. 79.65% were not impaired in activities of daily living (ADL), and 88.07% and 85.88% did not have the habit of drinking and smoking, respectively. 33.99% of the participants exercised consistently, the average sleep duration was 7.15 h, and the average depression score was 9.11. In addition, 25.95% of the sample population had fallen in the past year. 83.89% had no anxiety symptoms, and 28.78% considered their overall health symptoms to be good.

Regression model results

First, we used linear regression models to confirm the correlation between falls and self-rated health and anxiety symptoms in older chronic disease multimorbid personsmultimorbids, and the regression results are shown in Tables 3 and 4. Table 3 used anxiety symptoms were the dependent variable, and in the unadjusted model (Model 1), falls had a strong effect on the anxiety symptoms of older people with chronic multimorbidity, that is to say, the appearance of falls tended to contribute to the emergence of anxiety symptoms in older persons with chronic multimorbidity. After the model was adjusted several times (from Model 2 to Model 4), i.e., after incorporating control variables related to socio-demographic characteristics (age, gender, place of residence, and marital status), family socio-economic characteristics (family economic symptoms, type of residence, pension insurance, and health insurance), and healthy living conditions (smoking, drinking, daily exercise, hours of sleep, depression symptoms, and ADLs), the relationships between falls and anxiety symptoms in older persons with chronic multimorbidity were significant (β = -0.1703, $p < 0.01$). It can be found that falls were still significantly associated with older chronic multimorbid persons' own anxiety symptoms, but this coefficient slightly decreased.

As shown in Table 4, we replaced the dependent variable with self-rated health and found that falls were significantly associated with the self-rated health of older persons with chronic multimorbidity. (β = 0.5590, $p < 0.01$), that is, the more frequently falls occurred, the worse the older chronic multimorbid persons' assessment of their own health level was. As the model was adjusted by incorporating groups of control variables several times, it was still possible to find a significant negative effect of falls on the self-rated health of older people with chronic multimorbidity.

Analysis of moderating effects

Table 5; Fig. 3 show the moderating role of psychological resilience between falls and self-rated health and anxiety status in older persons with chronic multimorbidity. In particular, when anxiety was the dependent variable, we

Table 2 Descriptive statistical analysis

Characteristics	N/Mean ± SD	%
Sex		
Male	1216	41.46
Female	1717	58.54
Age		
60–70	426	14.52
71–80	977	33.31
81–90	867	29.56
91 above	663	22.61
Marital status		
Married	1367	46.61
Divorced/Widowed/Never married	1566	53.39
Residence		
unban	1535	52.34
rural	1398	47.66
Family economic symptoms		
very rich	65	2.22
rich	495	16.88
so so	1977	67.41
poor	352	12.00
very poor	44	1.49
Co-residence		
with household member(s)	2344	79.91
alone	515	17.56
in an institution	74	2.53
Pension insurance		
Yes	1177	40.13
No	1756	59.87
Medical insurance		
Yes	1555	53.02
No	1378	46.98
ADL		
Impaired	597	20.35
No impaired	2336	79.65
Depression symptom	9.11 ± 3.99	
Smoke		
Yes	414	14.12
No	2519	85.88
Drink		
Yes	350	11.93
No	2583	88.07
Exercise		
Yes	995	33.99
No	1938	66.01
Sleep	7.15 ± 2.34	
Chronic diseases		
< 3	1515	51.65
≥ 3	1418	48.35
Falls		
Yes	761	25.95
No	2172	74.05
Anxiety symptom	1.82 ± 3.15	
Self-rated health		
very good	262	8.93

Table 2 (continued)

Characteristics	N/Mean ± SD	%
good	844	28.78
so so	1208	41.19
bad	572	19.50
very bad	47	1.60

found that psychological resilience had a significant effect on the occurrence of falls and anxiety (β=−0.151 [-0.217, -0.084], $p<0.01$), that is to say, the effects of falls and anxiety symptoms on older persons with chronic multimorbidity were mitigated in participants with higher levels of psychological resilience. In contrast, when self-rated health was used as the dependent variable, there was no significant interaction effect of psychological resilience on falls and self-rated health (β = -0.005, p=0.629), which means that psychological resilience failed to play a moderating role between falls and self-rated health among the older persons with chronic multimorbidity.

Robustness test
In this study, we replaced the test model to test robustness. Table 6 shows that when the dependent variable was anxiety, the coefficients before and after model replacement were 0.5590 and 0.2597, respectively, which are significant at the 1% and 5% test levels, and when the dependent variable was self-rated health, the coefficients before and after model replacement were −0.1703 and −0.3639, respectively, which are also significant at the 1% test level older persons with chronic multimorbidity. The results obtained from both regressions were consistent. This finding showed that the correlations between the occurrence of falls and the anxiety status and self-rated health of were indeed statistically significant and passed the robustness test.

Heterogeneity analysis
Building on previous research, we analysed the heterogeneity of the regression relationships and the moderating effects by grouping participants on the basis of sex, residence, and the number of chronic diseases. Table 7 presents the regression results by gender. The analysis revealed that the effects of falls on self-rated health and anxiety are heterogeneous among older Chinese adults with chronic multimorbidity. Specifically, females were more likely to report poorer self-rated health and develop anxiety symptoms following falls than males were. In addition, psychological resilience had a more significant moderating effect on anxiety symptoms in females than in males.

Table 8 shows the results of the heterogeneity test for the different residence groups. The results revealed that when the dependent variable was anxiety symptoms, the effect of falls was more significant for urban older persons with chronic multimorbidity, whereas when the dependent variable was self-rated health, the effect of falls was more significant for rural older persons with chronic multimorbidity. In other words, people living in cities were more likely to experience anxiety symptoms after a fall, whereas people living in rural areas were more likely to experience poorer self-rated health after falls. In addition, among the moderating effects, there was a significant moderating effect of psychological resilience on falls and anxiety among urban older persons with chronic multimorbidity.

The regression results for the number of chronic diseases group are shown in Table 9. The results showed that falls were more significantly associated with anxiety in older adults with three or more chronic diseases than in those with fewer than three chronic diseases and that the moderating effect of psychological resilience was more strongly pronounced in the group of older adults with three or more chronic diseases. Moreover, in both groups, the effect of falls on the self-rated health of older adults with three or more chronic conditions was more significant.

Discussion
In this study, we examined the relationships among falls, self-rated health status, and anxiety symptoms among older adults with chronic multimorbidity, as well as the moderating role of psychological resilience, using cross-sectional data from the CLHLS. Our findings indicated that falls were significantly negatively correlated with self-rated health and significantly positively associated with anxiety symptoms in this population. Additionally, psychological resilience was found to moderate the relationship between falls and anxiety symptoms. We also further confirmed the heterogeneity of falls in terms of both self-rated health and anxiety status across gender and residence groups.

First, the present study found that falls were negatively associated with self-rated health in Chinese older persons with chronic multimorbidity. This finding aligns with previous research. Previous studies have shown that falls interact with older adults' health levels, with more falls predicting poorer physical health, more negative emotions, and less physical activity in the near future for older adults living in the community [31]. In turn, poorer health also promotes the occurrence of falls in elderly individuals. Medical studies indicate that declines in

Table 3 Results of the regression analysis between falls and anxiety symptoms

	Model 1	Model 2	Model 3	Model 4
	Anxiety symptoms	Anxiety symptoms	Anxiety symptoms	Anxiety symptoms
Falls	1.0034***	0.9825***	0.8359***	0.5590***
	(0.1314)	(0.1313)	(0.1285)	(0.1120)
Age		-0.0223***	-0.0162**	-0.0232***
		(0.0064)	(0.0063)	(0.0059)
Sex		0.7514***	0.7067***	0.4325***
		(0.1210)	(0.1184)	(0.1103)
Marital status		0.0108	-0.0558	-0.1795
		(0.1360)	(0.1447)	(0.1258)
Residence		-0.1256	-0.2426**	-0.1975**
		(0.1146)	(0.1124)	(0.0989)
Family economic status			1.0697***	0.3894***
			(0.0857)	(0.0778)
Co-residence			0.1664	-0.2050*
			(0.1288)	(0.1126)
Pension insurance			-0.1230	-0.1664*
			(0.1145)	(0.1001)
Medical insurance			0.1709	0.2710***
			(0.1125)	(0.0979)
ADL				0.3441**
				(0.1348)
Depression symptom				0.3758***
				(0.0133)
Smoke				-0.1359
				(0.1513)
Drink				0.0171
				(0.1584)
Exercise				-0.0543
				(0.1075)
Sleep				-0.1216***
				(0.0216)
Constant	0.5938***	1.4286***	-1.9393***	-0.4023
	(0.1752)	(0.5393)	(0.6203)	(0.6592)
N	2933	2933	2933	2933
adj. R^2	0.019	0.036	0.086	0.312

Standard errors are in parentheses.

* $p<0.1$, ** $p<0.05$, *** $p<0.01$.

Table 4 Results of the regression analysis between falls and self-rated health

	Model 5	Model 6	Model 7	Model 8
	Self-rated health	Self-rated health	Self-rated health	Self-rated health
Falls	-0.2664***	-0.2716***	-0.2223***	-0.1703***
	(0.0385)	(0.0387)	(0.0375)	(0.0350)
Age		0.0027	0.0010	0.0062***
		(0.0019)	(0.0018)	(0.0019)
Sex		-0.0619*	-0.0453	0.0409
		(0.0357)	(0.0345)	(0.0344)
Marital status		0.0704*	0.0904**	0.1162***
		(0.0401)	(0.0422)	(0.0393)
Residence		-0.0167	0.0280	0.0252
		(0.0338)	(0.0328)	(0.0309)
Family economic status			-0.3649***	-0.2160***
			(0.0250)	(0.0243)
Co-residence			-0.0474	0.0190
			(0.0376)	(0.0352)
Pension insurance			-0.0397	-0.0228
			(0.0334)	(0.0312)
Medical insurance			-0.0711**	-0.0946***
			(0.0328)	(0.0306)
ADL				-0.2203***
				(0.0421)
Depression symptom				-0.0720***
				(0.0041)
Smoke				0.1308***
				(0.0472)
Drink				-0.2713***
				(0.0495)
Exercise				-0.1377***
				(0.0336)
Sleep				0.0212***
				(0.0067)
Constant	3.5749***	3.3788***	4.6230***	4.4963***
	(0.0513)	(0.1590)	(0.1810)	(0.2058)
N	2933	2933	2933	2933
adj. R^2	0.016	0.018	0.089	0.215

Standard errors are in parentheses.

* $p<0.1$, ** $p<0.05$, *** $p<0.01$.

lower extremity muscle function significantly contribute to falls in older adults. This decline is not merely an inevitable part of aging but is closely related to underlying chronic health conditions [32–35]. Consequently, older persons with chronic multimorbidity are more prone to falls, and the health problems that may be associated with falls, such as limb injuries (e.g., hip fracture), deterioration of physical and cognitive functioning, and poor trajectory of recovery from chronic diseases, directly affect older persons' assessment of their own health.

Another correlation study revealed that falls were positively correlated with anxiety symptoms in Chinese

Table 5 Results of moderating effects

	Variables	Coefficient	SE	t	p	95% CI	
						Lower	Upper
Anxiety symptoms(Y)							
Model 1 (R2=0.2642, F=351.99, $p<0.001$)							
Independent variable	Falls(X)	0.593	0.115	5.16	<0.01	0.367	0.818
Moderator variable	Psychological resilience(W)	-0.494	0.016	-30.72	<0.01	-0.526	-0.463
Interaction	X×W	-0.156	0.036	-4.37	<0.01	-0.226	-0.086
Model 2 (R2= 0.3367, F=88.55, $p<0.001$)							
Independent variable	Falls(X)	0.496	0.111	4.49	<0.01	0.279	0.713
Moderator variable	Psychological resilience(W)	-0.238	0.025	-9.37	<0.01	-0.288	-0.188
Interaction	X×W	-0.151	0.034	-4.43	<0.01	-0.217	-0.084
Self-reported health(Y)							
Model 1 (R2= 0.1508, F=174.57, $p<0.001$)							
Independent variable	Falls(X)	-0.189	0.036	-5.24	<0.01	-0.260	-0.119
Moderator variable	Psychological resilience(W)	0.109	0.005	21.63	<0.01	0.099	0.119
Interaction	X×W	-0.005	0.011	-0.44	0.661	-0.027	0.017
Model 2 (R2= 0.2263, F=51.44, $p<0.001$)							
Independent variable	Falls(X)	-0.169	0.035	-4.85	<0.01	-0.238	-0.101
Moderator variable	Psychological resilience(W)	0.054	0.008	6.67	<0.01	0.038	0.069
Interaction	X×W	-0.005	0.011	-0.48	0.629	-0.026	0.016

Model 1 unadjusted

Model 2 was adjusted for Socio-demographic characteristics (age, sex, residence status and marital status); family socio-economic characteristics (family economic status, co-residence, pension insurance and medical insurance); and healthy living conditions (ADL, depression symptoms, smoking, drinking, exercise and sleep)
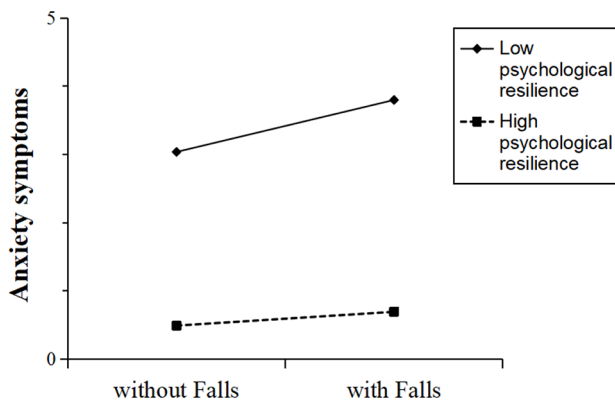

Fig. 3 The moderating role of psychological resilience in falls and anxiety symptoms

older persons with chronic multimorbidity. This finding is generally consistent with those of previous studies, indicating that falls contribute to anxiety symptoms and adversely affect the mental health of older adults [4, 21, 36]. Notably, anxiety symptoms are commonly associated with four psychological disorders triggered by falls, including fear of falling, fall-related self-efficacy, balance confidence, and outcome expectations [18]. Older persons with chronic multimorbidity are particularly vulnerable to poor mental health due to the cumulative effects of multiple chronic conditions [37]. The occurrence of falls also puts older persons at risk for recurrent falls and physical impairment, which in turn triggers a fear of repeated falls and a reduced sense of self-efficacy.

Previous studies have shown that it becomes more difficult for older persons to recover from fall-related injuries [38], thus, after experiencing a fall, older persons are more likely to develop a fear of falling again, which can manifest as a loss of confidence in their ability to perform everyday behaviors and limit and avoid participation in certain activities, which contributes to the development of anxiety symptoms, and the greater the degree of fear is, the more severe the anxiety symptoms are [39]. Moreover, the impaired health, functional deterioration, and decreased independence caused by falls may lead to gradual resistance to social participation, which not only reduces the exchange of daily information but also does not facilitate the venting of negative emotions and has a serious negative impact on all areas of older persons' lives, thus eroding their sense of self-efficacy [40] and triggering the emergence of anxiety symptoms. In addition, according to previous studies, anxiety can also increase the risk of falls in older adults through multiple mechanisms. Anxiety in the clinical setting usually has physical effects on a person [36]. Symptoms such as visual control disorders, muscle tension, and dizziness triggered by anxiety can easily lead to falls in older persons due to a lack of physical control [41]. Additionally, studies have highlighted that drugs for anxiety are themselves independent risk factors for falls because they can cause physical and cognitive side effects [42, 43]. Therefore, there should be an interplay between falls and anxiety.

Table 6 Results of the robustness test

Variable	Logit model	OLS model	Logit model	OLS model
	Anxiety	Anxiety	Self-reported health	Self-reported health
Falls	0.2597**	0.5590***	-0.3639***	-0.1703***
	(0.1273)	(0.1120)	(0.0988)	(0.0350)
Age	-0.0243***	-0.0232***	0.0173***	0.0062***
	(0.0072)	(0.0059)	(0.0051)	(0.0019)
Sex	0.4171***	0.4325***	0.0309	0.0409
	(0.1398)	(0.1103)	(0.0940)	(0.0344)
Marital status	-0.0826	-0.1795	0.3623***	0.1162***
	(0.1505)	(0.1258)	(0.1076)	(0.0393)
Residence	-0.0670	-0.1975**	0.1621*	0.0252
	(0.1188)	(0.0989)	(0.0848)	(0.0309)
Family economic status	0.2127**	0.3894***	-0.4890***	-0.2160***
	(0.0940)	(0.0778)	(0.0699)	(0.0243)
Co-residence	-0.3298**	-0.2050*	-0.0335	0.0190
	(0.1377)	(0.1126)	(0.0967)	(0.0352)
Pension insurance	-0.1422	-0.1664*	0.0310	-0.0228
	(0.1207)	(0.1001)	(0.0857)	(0.0312)
Medical insurance	0.1642	0.2710***	-0.1478*	-0.0946***
	(0.1175)	(0.0979)	(0.0838)	(0.0306)
ADL	0.2760*	0.3441**	-0.5792***	-0.2203***
	(0.1550)	(0.1348)	(0.1211)	(0.0421)
Depression symptom	0.3376***	0.3758***	-0.1488***	-0.0720***
	(0.0203)	(0.0133)	(0.0123)	(0.0041)
Smoke	-0.2608	-0.1359	0.3491***	0.1308***
	(0.1861)	(0.1513)	(0.1313)	(0.0472)
Drink	0.1988	0.0171	-0.5443***	-0.2713***
	(0.2135)	(0.1584)	(0.1332)	(0.0495)
Exercise	0.0850	-0.0543	-0.3066***	-0.1377***
	(0.1336)	(0.1075)	(0.0906)	(0.0336)
Sleep	-0.1066***	-0.1216***	0.0613***	0.0212***
	(0.0262)	(0.0216)	(0.0186)	(0.0067)
Constant	-3.6635***	-0.4023	1.1628**	4.4963***
	(0.8347)	(0.6592)	(0.5598)	(0.2058)
N	2933	2933	2933	2933
adj. R^2		0.312		0.215

Standard errors are in parentheses

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Furthermore, the present study highlighted the moderating role of psychological resilience.Previous research has demonstrated that psychological resilience effectively reduces anxiety and depression following falls in older adults and that enhancing psychological resilience may be a viable strategy for preventing and managing fall-related anxiety and depression [18]. In addition, many

Table 7 Results of the regression analysis by sex

Variable	Anxiety		Self-reported health	
	Female	Male	Female	Male
Falls	0.7242***	0.2828*	-0.1657***	-
	(0.1492)	(0.1657)	(0.0440)	0.1779***
				(0.0581)
Interaction (Falls × Psychological resilience)	-0.1340***	-0.1193**		
	(0.0440)	(0.0557)		
Constant	-0.3554	1.2327	4.5239***	4.5810***
	(1.1198)	(0.8802)	(0.3300)	(0.3085)
N	1717	1216	1717	1216
adj.R^2	0.346	0.226	0.213	0.214

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Note Control variables: Socio-demographic characteristics (age, sex, residence status and marital status); family socio-economic characteristics (family economic status, co-residence, pension insurance and medical insurance); and healthy living conditions (ADL, depression symptoms, smoking, drinking, exercise and sleep).

Table 8 Results of the regression analysis by residence

Variable	Anxiety		Self-reported health	
	Urban	Rural	Urban	Rural
Falls	0.7342***	0.3600**	-0.1366***	-
	(0.1614)	(0.1550)	(0.0494)	0.2061***
				(0.0495)
Interaction (Falls × Psychological resilience)	-0.1846***	-0.1099**		
	(0.0481)	(0.0482)		
Constant	-1.1219	-0.5090	4.6319***	4.4269***
	(0.9340)	(0.9142)	(0.2861)	(0.2922)
N	1535	1398	1535	1398
adj.R^2	0.319	0.307	0.220	0.212

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Note Control variables: Socio-demographic characteristics (age, sex, residence status and marital status); family socio-economic characteristics (family economic status, co-residence, pension insurance and medical insurance); and healthy living conditions (ADL, depression symptoms, smoking, drinking, exercise and sleep).

Table 9 Results of the regression analysis by the number of chronic diseases

Variable	Anxiety		Self-reported health	
	≥ 3	< 3	≥ 3	< 3
Falls	0.5554***	0.5520***	-0.1564***	-
	(0.1639)	(0.1546)	(0.0505)	0.1769***
				(0.0481)
Interaction (Falls × Psychological resilience)	-0.1637***	-0.1319***		
	(0.0494)	(0.0472)		
Constant	-1.2763	0.1573	5.0468***	4.2159***
	(1.0066)	(0.8734)	(0.3100)	(0.2719)
N	1418	1515	1418	1515
adj.R^2	0.325	0.293	0.216	0.219

* $p<0.1$, ** $p<0.05$, *** $p<0.01$

Note Control variables: Socio-demographic characteristics (age, sex, residence status and marital status); family socio-economic characteristics (family economic status, co-residence, pension insurance and medical insurance); and healthy living conditions (ADL, depression symptoms, smoking, drinking, exercise and sleep).

studies have confirmed the assertion that the moderating effects of psychological resilience can modify the impact of risk factors on psycho-social functioning [44] and are reflected in different groups. For example, soldiers are exposed to military operations [45], COVID-19 experiencers [46], and groups of children and adolescents [47, 48]. Therefore, high psychological resilience is beneficial for regulating mental states and mitigating anxiety symptoms triggered by negative events such as falls among older persons with chronic multimorbidity in China. However, regarding the relationship between falls and the self-rated health of older persons with chronic multimorbidity, our study revealed that psychological resilience did not play a significant moderating role, and we speculate that positive mental status is not sufficient to influence older persons' assessment of their physical health status. Self-rated health is a reliable and effective indicator of an individual's own health [49] and has been regarded as an important reference factor for determining morbidity, hospitalization and mortality [50], which reinforces the need for older persons to ensure objectivity and truthfulness in assessing their own health status. Therefore, psychological resilience fails to play a moderating role between falls and self-rated health, as it is difficult to influence older persons' assessment of their objective conditions, such as disease, functional status, and other health problems, through changes in mindset.

Finally, this study found that the effects of falls on the self-rated health and anxiety symptoms of Chinese older persons with chronic multimorbidity varied by sex, residence and number of chronic diseases. First, from a gender perspective, females were more likely to have poorer self-rated health and more severe anxiety symptoms in the future after falls. Similarly, the moderating effect of psychological resilience was more pronounced for females than for males. A study showed that the prevalence of post-fall fear was greater in women than in men and increased with age [51]. This suggests that the significant presence of post-fall fear in the female group means that they are more likely to develop anxiety symptoms after a fall. It has also been shown that women are generally more emotional than men are and are more susceptible to external influences at the mental level [52]. Therefore, compared with males, females in the chronic multimorbid group may experience greater fluctuations in their psychological state and level of cognition about themselves, resulting in poorer self-rated health and more severe anxiety symptoms, and psychological resilience, as a positive mental state, may also play a stronger moderating role in females. Second, from the perspective of residence, the results of the study revealed that older persons with chronic multimorbidity persons living in urban areas were more likely to experience anxiety after falls and that psychological resilience had a more significant moderating effect, whereas people living in rural areas were more likely to experience poorer self-rated health after a fall. This discrepancy may be attributed to different health shocks experienced in urban versus rural settings. For older urban persons, a relatively higher level of education leads to higher expectations of educational rewards, thus, fluctuations in their psychological state may be greater in the event of a setback similar to a fall. Moreover, life in towns and cities is richer than that in rural areas, which leads to greater life changes after a fall, which can have a more severe negative impact on mental health. In addition, in terms of the relationship between falls and self-rated health, many studies have shown that Chinese rural residents generally have worse self-rated health outcomes than their urban counterparts do because of unequal health opportunities and uneven utilization of healthcare services [53]. On the basis of this assertion, we can further confirm that rural older persons with chronic diseases are more likely to have a poorer assessment of their own health after experiencing an adverse event of a fall. Third, from the perspective of the number of chronic diseases, those with three or more chronic diseases were more likely to have poorer self-rated health and more severe anxiety symptoms in the future after falls. The role of psychological resilience in moderating these effects was notably stronger among those with three or more chronic diseases than among those with fewer than three chronic diseases. Research has shown that having two concurrent diseases increases the likelihood of elevated anxiety by 1.44 times, whereas having three or more diseases increases this likelihood by 2.3 times [37]. Thus, patients with three or more medical diseases are prone to anxiety, hence, they are also more likely to develop anxiety symptoms and have poorer self-rated health after experiencing falls. In addition, compared with older persons with <3 chronic diseases, older persons with ≥3 chronic diseases suffer more from the pain and financial burden of the disease, thus, psychological resilience also plays a significant role in moderating the relationship between falls and anxiety.

The strengths of this study are the selection of a sample from the National Population Survey, which provides sufficient data to explore the relationships between falls and self-rated health and anxiety symptoms in older people with chronic multimorbidity, and the focus on older people with chronic multimorbidity, which provides insight into the impact of falls on their physical and mental health and the role of psychological resilience. However, there are several limitations to this study. First, the study was analysed on the basis of a cross-sectional dataset. Therefore, our predicted results cannot be explained in depth in terms of causality and can only be understood statistically, and further research on falls and Chinese older chronic multimorbid persons' self-rated health

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and anxiety symptoms needs to be explored with longitudinal data. Second, the present study used a self-rated approach for the identification of falls, in which participants were asked to recall whether a fall had occurred in the past year. This approach may be subject to recall bias, thus, further research should also take a more accurate approach to the recording of falls, and deeper statistics on the number of falls and the degree of injury caused by falls may make the description of falls more complete and rigorous. Third, the methods used in this study are relatively common, and future research could use more diverse methods from other perspectives to further explore the relationships between falls and self-rated health and anxiety. Fourth, owing to the limitations of the questionnaire questions, the internal consistency coefficients of the psychological resilience scales we chose were low. Therefore, future research could attempt to design other scales to measure psychological resilience to ensure the rigor of the study. Finally, only psychological resilience is discussed as a moderating variable in this study. However, the potential moderating roles of other variables warrant exploration in subsequent studies.

Conclusion

Our findings suggest that there is a significant correlation between falls and self-rated health and anxiety symptoms in Chinese older persons with chronic multimorbidity. Additionally, psychological resilience was found to play a significant moderating role in mitigating the development of anxiety symptoms following a fall. In view of this, we should pay timely attention to the changes in the physical and mental health of older persons with chronic multimorbidity after falls and develop a series of interventions to promote older persons' physical recovery after a fall and alleviate anxiety. At the same time, future psychiatric interventions for anxiety in older persons with chronic multimorbidity can also start by improving their psychological resilience so that they can cope with the fall in a more positive way and minimize the negative impact of the fall on themselves.

Author contributions
Shaoliang Tang: research design, conceptualization, revision of the manuscript, language and supervision, funding acquisition. Jingyu Xu: data analysis, writing and revision of the manuscript. Xiaoyan Mao and Huilin Jiao data collation, inspection, and revision. Yuxin Qian: data collation, inspection, and revision. Gaoling Wang: project administration, resources, and supervision. All the authors contributed to the article and reviewed the final manuscript.

Declarations

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