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The relationship between sarcopenia and mental health status in Chinese older adults: the mediating role of activities of daily living

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Abstract

Background Most existing studies focus on either the relationship between sarcopenia and depressive symptoms or sarcopenia and cognitive functions. Few studies have examined depressive symptoms and cognitive functions simultaneously. This study aimed to analyze the relationship between sarcopenia and both depressive symptoms and cognitive functions in the elderly by introducing activities of daily living to explore the mediating role of activities of daily living between sarcopenia and mental health.

Methods This study used data from the 2015 and 2018 China Health and Retirement Longitudinal Study, including a total of 3,552 older adults aged 60 and above. We conducted descriptive statistical analysis and correlation analysis on the data and used seemingly unrelated regression to examine the relationship between sarcopenia, depressive symptoms, and cognitive functions in older adults. Bootstrap mediation analysis was used to further explore the mediating role of activities of daily living in the relationship between sarcopenia and depressive symptoms and cognitive functions in the elderly.

Results After adjusting for confounding factors, sarcopenia was positively correlated with depressive symptoms ($\beta = 0.663$, $p < 0.001$) and negatively correlated with cognitive functions (β=-0.748, $p < 0.001$), indicating a negative impact of sarcopenia on mental health. Activities of daily living mediated the relationship between sarcopenia and mental health, with a stronger mediating effect between sarcopenia and depressive symptoms (18.77%, $\beta = 0.125$, 95%CI (0.035, 0.222)) than between sarcopenia and cognitive functions (12.82%, β=-0.099, 95%CI (-0.162, -0.035)).

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Conclusions Activities of daily living partially mediated the relationship between sarcopenia and mental health status in Chinese older adults. Interventions targeting sarcopenia and activities of daily living may be an effective way to prevent and improve the mental health status of older adults.

Keywords Sarcopenia, Mental health, Older adults, Activities of daily living, Depressive symptoms, Cognitive functions

Introduction

With advances in medical technology, improvements in public health, and higher living standards, the average global life expectancy has significantly increased [1]. Global aging has become one of the greatest challenges of the 21st century. As the world's most populous nation, China has experienced a deepening trend of population aging in recent years. By 2050, it is projected that the population aged 65 and over will peak at nearly 380 million, accounting for about 27.90% of the total population [2]. A large elderly population will impose a significant economic burden on both society and families, increasing the pressure on social security systems [3] In an aging society, mental health issues among older adults have become a focal point of social concern.

Mental health disorders are one of the leading factors contributing to the rising disease burden in China [4]. Depressive symptoms, as one of the most common mental health disorders, are characterized by notable reductions in interest, vitality, and memory [5]. Depression can affect sleep and quality of life in older adults and, as symptoms worsen, may increase the risk of self-harm and suicide [6, 7]. Furthermore, previous studies have shown that depression combined with cognitive impairment is a common clinical presentation in older adults [8]. Currently, around 24.90% of older adults in China experience some degree of cognitive impairment [9]. Mild cognitive impairment (MCI) is a transitional state between normal aging and dementia, characterized by slight memory loss that does not meet clinical criteria for dementia. MCI represents an early stage in the development of dementia [10]. Approximately 15%~28% of individuals with MCI may progress to dementia within a year [11, 12], and late-life depression has been identified as a potential precursor to dementia [13, 14]. In China, the annual cost of dementia in older adults exceeds $167.7 billion [15, 16]. Mental health has become a critical public health issue in aging societies.

Sarcopenia, an age-related disease characterized by a decline in muscle mass and strength [17], has become a common health concern among older adults. Sarcopenia not only affects the physical health of older adults but may also have negative implications for mental health. Cabanas et al. found that declines in muscle strength contribute to the occurrence of anxiety and depressive episodes in adults [18]. Moreover, increasing evidence indicates a strong association between low muscle strength and the risk of cognitive impairment and neurodegenerative diseases such as dementia and Parkinson's disease [19–21]. This dual impact on physical and mental health not only reduces the quality of life for older adults but also imposes a significant burden on society and families [22]. Based on a review of existing literature, we propose the following hypotheses.

Hypothesis 1 Sarcopenia has a significant positive effect on depressive symptoms in older adults.

Hypothesis 2 Sarcopenia has a significant negative effect on cognitive functions in older adults.

Hypothesis 3 Sarcopenia has a negative impact on the mental health of older adults (supported by Hypotheses 1 and 2).

Existing research has shown that sarcopenia is associated with adverse outcomes such as falls, fractures, and disability, leading to declines in physical function and affecting the ability to perform daily activities in older adults [23, 24]. Li and Yan suggested that physical dysfunction is closely related to depressive symptoms, as impaired physical function and reduced activity levels in older adults can trigger depressive symptoms, while worsening depression further affects their ability to perform daily activities, creating a bidirectional relationship [22, 25]. Zhu et al. found a dose-response relationship between physical activity and cognitive functions, where moderate physical activity significantly reduces the risk of cognitive impairment in older adults [26]. However, most existing studies have analyzed the relationships between sarcopenia, activities of daily living, and mental health outcomes (depressive symptoms or cognitive functions) in pairs, with few exploring whether activities of daily living mediate the relationship between sarcopenia and both depressive symptoms and cognitive functions. Therefore, by introducing activities of daily living ability, we further reveal the specific impact mechanism of sarcopenia on the mental health of the elderly and provide a theoretical basis for formulating intervention measures for sarcopenia and improving the mental health of the elderly. Based on this, we propose the following hypotheses (Fig. 1):

Hypothesis 4 Activities of daily living mediate the relationship between sarcopenia and depressive symptoms in older adults.

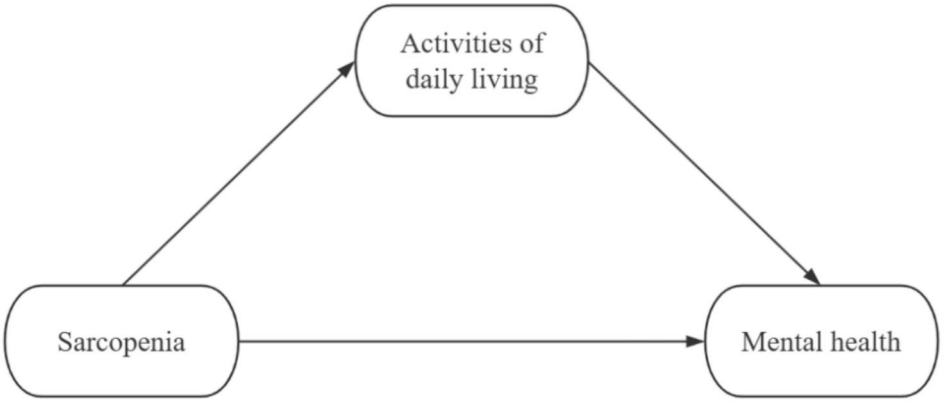

Fig. 1 Theoretical hypothesis model

Hypothesis 5 Activities of daily living mediate the relationship between sarcopenia and cognitive functions in older adults.

Hypothesis 6 Activities of daily living mediate the relationship between sarcopenia and the mental health of older adults (supported by Hypotheses 4 and 5).

Methods

Participants

Data for this study were derived from the China Health and Retirement Longitudinal Study (CHARLS) in 2015 and 2018. CHARLS is a large-scale interdisciplinary survey project jointly implemented by Peking University and Wuhan University, which launched a baseline survey in 2011, covering 150 county-level units and 450 village-level units across the country, aiming to collect a representative set of high-quality data on middle-aged and elderly people aged 45 and above in China. The study has been approved by the Biomedical Ethics Committee of Peking University (IRB00001052-11015), and all participants have signed informed consent before the investigation. Using the 2015 CHARLS data as the baseline, we initially surveyed 21,095 participants. First, we excluded samples where participants were aged ≤ 60 years or had missing data on sarcopenia-related variables in the baseline survey. Second, we excluded samples with missing data on activities of daily living and mental health variables in the 2018 survey. Third, we removed cases with attrition across the 2015 and 2018 waves or missing data on sociodemographic characteristics, health behaviors, and other covariates. Ultimately, 3,552 participants were included in the analysis. Details are shown in Fig. 2.

Measures

Sarcopenia

In the baseline survey conducted in 2015, this study evaluated the muscle condition of elderly individuals based on the assessment criteria established by the Asian Working Group for Sarcopenia (AWGS) in 2019. Sarcopenia was defined using three criteria: muscle strength, skeletal muscle mass, and physical performance [27]. (1) Muscle strength: Evaluated using a handgrip test. Participants unable to perform the test due to surgery, swelling, or other health conditions were excluded. For other participants, the grip strength of both hands was measured twice, with a 15-second interval between measurements. Muscle weakness was defined as grip strength < 28.0 kg for men and < 18.0 kg for women. (2) Skeletal muscle mass: Estimated using a formula to calculate appendicular skeletal muscle mass (ASM) [28]. Previous research has shown that ASM prediction models correlate well with dual-energy X-ray absorptiometry (DXA) measurements in Chinese adults [19].

$$ASM = 0.193 * weight + 0.107 * height \\ -4.157 * gender - 0.037 * age - 2.631$$

The formula includes height, weight, and age, with units in meters, kilograms, and years, respectively. A value of 1 is assigned to males and 2 to females. Low muscle mass was defined as the lowest 20% of height-adjusted ASM (ASM/height^2) for each sex in the study population, specifically < 6.87 kg/m^2 for men and < 5.05 kg/m^2 for women [19, 29]. (3) Physical performance: Assessed using a 2.5-meter walking test conducted twice, and a five-time chair stand test (without arm support). Declined physical function was defined as walking speed < 1 m/s, chair stand test time ≥ 12 s, or inability to complete the test [30]. The diagnostic criteria for sarcopenia require both reduced muscle mass and either impaired physical function or decreased muscle strength. Based on these criteria, participants were classified as having no sarcopenia, possible sarcopenia, or sarcopenia, with corresponding scores of 0 to 2.

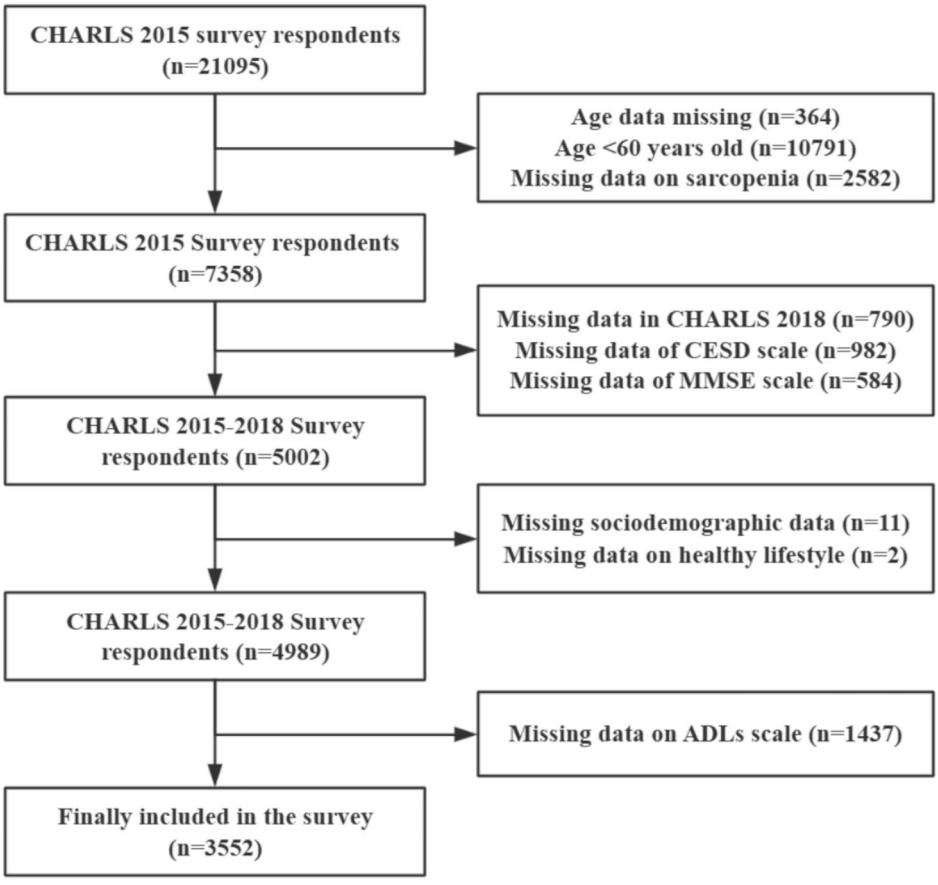

Fig. 2 Sample inclusion flow chart

Activities of daily living

In the 2018 survey, we assessed the daily living abilities of older adults using the Activities of Daily Living (ADL) scale, which consists of two components: Basic Activities of Daily Living (BADL) and Instrumental Activities of Daily Living (IADL) [31–33]. BADL includes self-feeding, dressing, bathing, getting in and out of bed, using the toilet, and controlling bowel and bladder functions. IADL includes household chores (cleaning, washing dishes, etc.), cooking, shopping, managing finances (paying bills, bookkeeping, etc.), making phone calls, and taking medication. Each of the 12 items was scored based on four possible responses: "unable to complete" (0 points), "difficulty, requires help" (1 point), "difficulty but can complete" (2 points), and "no difficulty" (3 points). The total score ranged from 0 to 36, with higher scores indicating greater daily living abilities. The ADL scale had good reliability (Cronbach's alpha = 0.797) and validity in this study (KMO = 0.878, $p < 0.01$).

Mental health

In the 2018 follow-up, we assessed the mental health of older adults using measures of depressive symptoms and cognitive functions [3]. Depressive symptoms were measured using the 10-item simplified version of the Center for Epidemiologic Studies Depression Scale (CESD-10), which has been widely used in Chinese populations and demonstrates good reliability (Cronbach's alpha = 0.780) and validity (KMO = 0.877, $p < 0.01$) [34, 35]. Depressive levels were evaluated by asking about feelings and behaviors over the past week, with a total score of 30. Higher scores indicate more severe depression and scores of 10 or higher are classified as having depressive symptoms. Cognitive functions were measured using a Chinese version of the Mini-Mental State Examination (MMSE), which assesses seven areas: orientation to time (5 points), orientation to place (5 points), immediate recall (3 points), attention and calculation (5 points), delayed recall (3 points), language (8 points), and visuospatial skills (1 point). The total score is 30, with higher scores indicating better cognitive functions. In this research, the MMSE scale showed good reliability (Cronbach's alpha = 0.751) and validity (KMO = 0.814, $p < 0.01$).

Covariates

Based on previous research [22, 36], we also included sociodemographic characteristics and health-related lifestyle factors as covariates. These factors include: age (1 = 60 ~ 65 years, 2 = 66 ~ 75 years, 3 = 76 years and above), gender (0 = female, 1 = male), education level (1 = illiterate or semi-literate, 2 = primary school, 3 = middle school and above), marital status (0 = without spouse, 1 = with spouse), current residence (0 = rural, 1 = urban), region (The classification follows China's regional economic development theory [37]: 1 = eastern region, 2 = central region, 3 = western region), number of chronic diseases (Currently has several kinds of chronic diseases? 0 = 0, 1 = 1, 2 = 2, 3 = ≥ 3), sleep duration (How many hours of actual sleep did you get at night? 1 = < 6 h, 2 = 6–8 h, 3 = > 8 h), self-rated health (How do you feel about your health? 1 = good, 2 = fair, 3 = poor), physical exercise (Whether to exercise three or more times per week, and the duration of each exercise is not less than 30 min? 0 = no, 1 = yes), smoking (0 = no, 1 = yes), and drinking (0 = no, 1 = yes).

Statistical analysis

This study used Stata 17.0 for statistical analysis, performing descriptive analysis and characteristic difference analysis of older adults with different levels of ADL, depressive symptoms, and cognitive functions. Categorical data were described using frequencies (percentages), while continuous data were summarized with means and standard deviations. The correlations among all study variables were also measured. Based on previous research [3], considering that depressive symptoms and cognitive functions are two interrelated factors, we applied seemingly unrelated regression (SUR) to model the relationships. A regression model was developed with depressive symptoms and cognitive functions as dependent variables, and a Breusch-Pagan test was conducted. SUR effectively addresses simultaneous bias, controls for the correlation between the equation disturbances, and ensures the robustness of the results. Mediation analysis was conducted with sarcopenia as the independent variable (X), ADL as the mediator (M), depressive symptoms as the dependent variable (Y_1), and cognitive functions as the dependent variable (Y_2). The mediation effect was tested using the Bootstrap method with 5000 resampling iterations. If the confidence interval did not include zero, the effect was considered significant. All tests were two-tailed, and a p-value of less than 0.05 was considered statistically significant.

Results

Descriptive statistical analysis

Among the 3,552 older adults included in this study, 1,676 were male (47.18%) and 1,876 were female (52.82%). A total of 2,798 participants (78.77%) had a spouse, while 754 (21.23%) did not. The majority were illiterate or semi-literate (53.27%) and primarily resided in rural areas (75.68%). Most of the elderly participants had chronic diseases, with 679 individuals (19.12%) having one chronic condition, 743 (20.92%) having two, and 1,821 (51.27%) having three or more chronic diseases. Additionally, 225 individuals (6.33%) were diagnosed with sarcopenia, and 338 (9.52%) were suspected to have sarcopenia. The scores for ADL, depressive symptoms, and cognitive functions in older adults were 33.67 ± 4.01, 9.54 ± 6.71, and 20.79 ± 5.39, respectively. There were significant differences in ADL and mental health status of the elderly in terms of age, gender, educational level, marital status, current residence, region, number of chronic diseases, sleep duration, self-reported health status, physical exercise, smoking, drinking, and sarcopenia status. Detailed information can be found in Table 1.

Correlation analysis

The correlations between the main variables, as shown in Table 2, indicate significant relationships between sarcopenia, ADL, depressive symptoms, and cognitive functions. Sarcopenia is negatively correlated with ADL and cognitive functions in older adults and positively correlated with depressive symptoms. ADL is negatively correlated with depressive symptoms and positively correlated with cognitive functions. Finally, depressive symptoms are negatively correlated with cognitive functions in older adults.

Seemingly uncorrelated regression

The Breusch-Pagan test results showed a significant correlation between the two models ($p < 0.001$), suggesting potential heteroscedasticity [38]. Consequently, SUR was used to estimate the two equations. The results indicated that sarcopenia is a positive predictor of depressive symptoms ($\beta = 0.663$, $p < 0.001$), confirming Hypothesis 1. Sarcopenia was also found to be a negative predictor of cognitive functions in older adults (β = -0.748, $p < 0.001$), confirming Hypothesis 2. As shown in Table 3, sarcopenia is a negative predictor of mental health in older adults, supporting Hypothesis 3.

Analysis of mediation effects

By controlling for covariates such as age, gender, and marital status, we conducted a mediation analysis with sarcopenia as the independent variable, ADL as the mediator, and depressive symptoms and cognitive functions as the dependent variables. As shown in Table 4, sarcopenia negatively predicted ADL (β = -0.380, -0.446, $p < 0.01$) and cognitive functions (β = -0.772, $p < 0.01$), and positively predicted depressive symptoms ($\beta = 0.663$, $p < 0.01$). ADL negatively predicted depressive symptoms

Table 1 Distribution of activities of daily living, depressive symptoms, and cognitive functions in older adults with different demographic characteristics

Variables	Overall (*N* = 3552)	Activities of Daily Living			Depressive Symptoms			Cognitive Functions		
		M	SD	*p*	M	SD	*p*	M	SD	*p*
Age (years)				< 0.001			0.016			< 0.001
60 ~ 65	1676(47.18)	34.16	3.53		9.62	6.73		21.16	5.23	
66 ~ 75	1547(43.55)	33.38	4.25		9 0.66	6.80		20.78	5.43	
76 and above	329(9.26)	32.59	4.76		8.52	6.14		18.97	5.62	
Gender				< 0.001			< 0.001			< 0.001
Male	1676(47.18)	22.02	3.93		8.44	6.14		22.31	4.64	
Female	1876(52.82)	21.37	4.05		10.52	7.05		19.44	5.65	
Education level				< 0.001			< 0.001			< 0.001
Illiterate or semi-illiterate	1892(53.27)	21.22	4.24		10.77	7.02		18.23	5.18	
Primary school	919(25.87)	21.88	3.96		8.68	6.22		22.86	4.00	
Middle school and above	741(20.86)	22.57	3.23		7.44	5.74		24.78	3.59	
Marital status				< 0.001			< 0.001			< 0.001
With spouse	2798(78.77)	21.84	3.88		9.21	6.55		21.23	5.23	
Without spouse	754(21.23)	21.05	4.42		10.75	7.15		19.15	5.52	
Current residence				< 0.001			< 0.001			< 0.001
Rural	2688(75.68)	21.41	4.15		10.16	6.76		19.95	5.33	
Urban	864(24.32)	22.49	3.41		7.60	6.18		23.42	4.67	
Region				< 0.001			< 0.001			< 0.001
Eastern region	1181(33.25)	22.13	3.46		8.13	6.20		21.27	5.26	
Central region	1251(35.22)	21.42	4.29		9.63	6.67		21.04	5.34	
Western region	1120(31.53)	21.47	4.19		10.92	6.98		20.01	5.50	
Number of chronic diseases				< 0.001			< 0.001			< 0.001
0	309(8.70)	23.06	2.04		6.95	5.49		20.11	5.40	
1	679(19.12)	22.43	3.15		8.03	6.12		20.34	5.42	
2	743(20.92)	21.99	3.81		8.84	6.35		20.47	5.61	
≥ 3	1821(51.27)	21.03	4.48		10.83	6.97		21.21	5.25	
Sleep duration (hours)				< 0.001			< 0.001			< 0.001
< 6	1428(40.20)	20.96	4.55		11.83	6.97		20.22	5.35	
6 ~ 8	1763(49.63)	22.29	3.36		7.92	6.02		21.60	5.20	
> 8	361(10.16)	21.49	4.19		8.34	6.29		19.10	5.78	
Self-reported health status				< 0.001			< 0.001			< 0.001
Good	556(15.65)	22.88	2.83		6.30	5.33		20.44	5.77	
Fair	1729(48.68)	22.48	2.88		8.31	5.95		21.25	5.23	
Poor	1267(35.67)	20.04	5.10		12.64	7.03		20.32	5.38	
Physical exercise				< 0.001			< 0.001			< 0.001
Yes	1869(52.62)	22.05	3.49		8.98	6.43		21.39	5.24	
No	1683(47.38)	21.26	4.48		10.16	6.96		20.13	5.48	
Smoking				0.002			0.044			< 0.001
Yes	861(24.24)	22.03	3.57		9.15	6.36		21.45	4.96	
No	2691(75.76)	21.56	4.14		9.66	6.81		20.58	5.50	
Drinking				< 0.001			< 0.001			< 0.001
Yes	1067(30.04)	22.34	3.20		8.32	6.10		21.90	5.07	
No	2485(69.96)	21.39	4.28		10.06	6.90		20.31	5.45	
Sarcopenia status				< 0.001			< 0.001			< 0.001
No-sarcopenia	2989(84.15)	21.79	3.92		9.33	6.65		21.14	5.30	
Possible sarcopenia	338(9.52)	21.89	3.63		9.92	6.62		19.36	5.53	
Sarcopenia	225(6.33)	19.78	5.17		11.78	7.30		18.30	5.40	

N is the total number of samples, M is the means, SD is the standard deviations

Table 2 Results of the correlation analysis of the main variables

Variables	M ± SD	Sarcopenia	Activities of Daily Living	Depressive Symptoms	Cognitive Functions
Sarcopenia	0.22 ± 0.55	1.000			
Activities of Daily Living	33.67 ± 4.01	-0.100**	1.000		
Depressive Symptoms	9.54 ± 6.71	0.087**	-0.330**	1.000	
Cognitive Functions	20.79 ± 5.39	-0.153**	0.255**	-0.239**	1.000

**$p < 0.01$

Table 3 Results of seemingly uncorrelated regression analysis

Variables	Depressive Symptoms		Cognitive Functions	
	β	SE	β	SE
Sarcopenia	0.663***	0.188	-0.748***	0.141
Age	-0.359*	0.161	-0.749***	0.121
Gender	-1.397***	0.247	1.749***	0.186
Education level	-0.897***	0.140	2.722***	0.105
Marital status	-0.941***	0.252	0.924***	0.189
Current residence	-1.567***	0.253	1.452***	0.190
Region	0.975***	0.124	-0.562***	0.093
Number of chronic diseases	0.654***	0.106	0.303***	0.080
Sleep duration	-1.673***	0.157	-0.243*	0.118
Self-reported health status	2.536***	0.156	-0.135	0.118
Physical exercise	-0.884***	0.199	0.774***	0.150
Smoking	0.681**	0.259	-0.280	0.195
Drinking	-0.280	0.235	0.130	0.177
N	3552		3552	
R2	0.242		0.333	

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

(β = -0.329, $p < 0.01$) and positively predicted cognitive functions ($\beta = 0.222$, $p < 0.01$) (The regression parameters for the covariates in the mediating effect are shown in the Appendix).

The mediation effect test, based on the Bootstrap method with 5,000 resampling iterations, showed that the direct effect of sarcopenia on both depressive symptoms and cognitive functions in older adults was significant ($\beta = 0.541$, 95%CI (0.180, 0.903); β = -0.673, 95%CI (-0.945, -0.401)). ADL had a significant mediating effect between sarcopenia and depressive symptoms ($\beta = 0.125$, 95%CI (0.035, 0.222)), accounting for 18.77% of the total effect, confirming Hypothesis 4. ADL also had a significant mediating effect between sarcopenia and cognitive functions (β = -0.099, 95%CI (-0.162, -0.035)), accounting for 12.82% of the total effect, confirming Hypothesis 5 (see Table 5; Fig. 3 for details). Sarcopenia reduces activities of daily living, which leads to increased depressive symptoms and decreased cognitive functions, thereby negatively affecting mental health. Therefore, ADL acts as a mediator between sarcopenia and mental health, confirming Hypothesis 6.

Table 5 Mediating effect test between Sarcopenia and mental health

Outcome	Effect	β	95% bootstrap confidence interval		Proportion
			Lower	Upper	
Depressive symptoms	Total effect	0.666	0.297	1.035	
	Direct effect	0.541	0.180	0.903	
	Indirect effect	0.125	0.035	0.222	18.77%
Cognitive functions	Total effect	-0.772	-1.049	-0.495	
	Direct effect	-0.673	-0.945	-0.401	
	Indirect effect	-0.099	-0.162	-0.035	12.82%

Discussion

This study utilized data from the 2015 and 2018 CHARLS to explore the relationship between sarcopenia and mental health in older adults in China. We further examined the mediating role of ADL through the lens of depressive symptoms and cognitive functions. Our study found that sarcopenia was positively associated with depressive

Table 4 The mediating effect of activities of daily living on the relationship between Sarcopenia and mental health in older adults

Consequent	Antecedent	Depressive Symptoms			Cognitive Functions		
		β	SE	t	β	SE	t
Depressive symptoms/ Cognitive Functions	Sarcopenia	0.663	0.188	3.541***	-0.772	0.141	-5.470***
	R^2		0.241			0.333	
	F		93.783***			176.380***	
Activities of Daily Living	Sarcopenia	-0.380	0.120	-3.174**	-0.446	0.122	-3.656***
	R^2		0.140			0.098	
	F		47.866***			38.385***	
Depressive symptoms/Cognitive Functions	Sarcopenia	0.541	0.184	2.936**	-0.673	0.139	-4.849***
	ADL	-0.329	0.026	-12.746***	0.222	0.019	11.637***
	R^2		0.275			0.357	
	F		103.016***			178.743***	

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

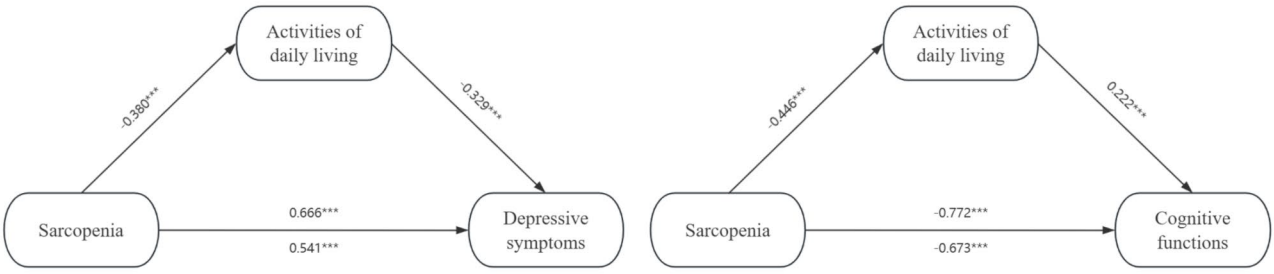

Fig. 3 Mediation models between sarcopenia and mental health in older adults

symptoms and negatively associated with cognitive functions in older adults. ADL played a significant mediating role in both relationships, but compared with depressive symptoms, the impact on cognitive functions was relatively small.

Relationship between sarcopenia and mental health in older adults

Our study found a significant relationship between sarcopenia and mental health in older adults. Sarcopenia is a risk factor for the worsening of depressive symptoms and cognitive decline, which is consistent with previous research findings [19, 39]. Sarcopenia is positively correlated with depressive symptoms, possibly because it leads to a decline in the quality and function of skeletal muscles, particularly in the limbs. This decline reduces muscle strength and balance, increasing the elderly's fear of falling and excessive concern about their health, which can create a psychological environment conducive to the development of negative emotions such as depression and anxiety [40]. Additionally, the onset of sarcopenia is often associated with chronic inflammation, which is a potential precursor to mental health issues [41]. Cohort studies from the United States and France have found that sarcopenia is often accompanied by elevated levels of inflammatory markers such as C-reactive protein, interleukin-6, and tumor necrosis factor-α [42, 43]. These inflammatory factors may accelerate muscle breakdown, disrupt the function of brain neurons and glial cells, impair cognitive and emotional regulation, and increase the risk of depression and cognitive disorders.

Additionally, Nishikawa et al. found that the progression of sarcopenia may disrupt metabolic functions, such as insulin resistance and lipid metabolism abnormalities [44]. Skeletal muscle plays a critical role in regulating glucose metabolism through insulin-β mechanisms [45]. Reduced skeletal muscle mass may lead to decreased insulin sensitivity, triggering insulin resistance, which can negatively affect cognitive function [46]. This could be the underlying mechanism linking sarcopenia to cognitive decline. Insulin resistance may also lead to an increase in visceral fat and a decrease in subcutaneous fat [21]. Research by Falabella and Chen et al. found that this abnormal fat metabolism is associated with an increased risk of Alzheimer's disease, depression, and other disorders [47, 48]. Sarcopenia affects the mental health of older adults to some extent, and the persistence and deepening of depressive symptoms may also increase the risk of developing sarcopenia in older adults, with the two interacting with each other [22, 49].

The mediating role of ADL between sarcopenia and mental health in older adults

This study also found that ADL mediates the relationship between sarcopenia and mental health. This provides new evidence for existing research [19, 50], suggesting that sarcopenia may affect mental health by limiting ADL, thereby increasing the risk of cognitive impairment and depressive symptoms. As individuals age, sarcopenia leads to the gradual decline of muscle mass and strength, making it increasingly difficult for older adults to perform basic daily activities. In the human skeletal muscle system, damage to one tissue can lead to secondary damage in other tissues [51]. A study from Belgium supports this idea, finding that individuals with sarcopenia are four times more likely to develop osteoporosis compared to those without sarcopenia [52]. Reduced muscle mass and lower bone density may interact, increasing the risk of falls and fractures in older adults, further reducing ADL. This decline in functional independence may lead to a greater dependency on others, which in turn increases the likelihood of mental health issues, including depression and cognitive decline [25, 53, 54].

Importantly, our study also reveals that ADL has a stronger mediating effect on depressive symptoms (18.77%) than on cognitive functions (12.82%) in older adults. This may be because ADL has a more direct and immediate impact on depressive symptoms in older adults. When their ability to perform daily activities declines, mobility challenges can lead to social isolation and a lack of social support, fostering feelings of loneliness and loss. Social isolation is a well-established risk factor for depressive symptoms [55, 56]. Additionally, functional limitations can increase the family's economic burden, diminishing the older adult's sense of self-worth and leading to helplessness, shame, and low self-esteem,

which can trigger or intensify depressive symptoms. In contrast, the impact on cognitive functions tends to be more gradual and indirect. Some studies have found that declines in ADL are often associated with atrophy in the frontal lobe and hippocampus, which are critical regions involved in cognitive decline [57, 58]. However, this degeneration is gradual and may take years to become evident [59]. Therefore, the mediating role of ADL between sarcopenia and depressive symptoms is more significant.

Implications

First, this study provides valuable insights for public health policy development for older adults, particularly in promoting sarcopenia screening and prevention strategies within communities and elder care institutions. Emphasizing sarcopenia in health management for older adults can help in early identification of at-risk populations. Second, supporting ADL should be a priority in elder care. Physical rehabilitation, functional exercises, and assistive tools can help older adults maintain or improve their ADL abilities [60, 61], reducing depressive symptoms and slowing cognitive decline. Third, a multi-level intervention approach is recommended. Given the complex relationship between sarcopenia and mental health, comprehensive interventions including physical, psychological, and social support should be implemented.

Strengths and limitations

Our study offers several notable strengths. First, this study focuses on the elderly in China, with strong regional and pertinence, filling the research gap on the relationship between sarcopenia and mental health in a specific Chinese population; Secondly, the mediating role of daily living ability between sarcopenia and mental health is revealed, which helps to understand the influence path of sarcopenia on mental health of the elderly more deeply, and provides a new perspective for early detection, diagnosis and treatment of mental health problems in the elderly. Finally, we paid attention to the two key mental health dimensions of depressive symptoms and cognitive functions at the same time, which is helpful to further reveal the mechanism of sarcopenia's influence on the mental health of the elderly, to make the analysis more comprehensive.

This study has certain limitations. First, it utilizes only two waves of data from 2015 to 2018, limiting the period and making it challenging to establish a causal relationship between sarcopenia and mental health. Future studies could consider longitudinal research using data from multiple waves. Second, some mental health variables, such as depressive symptoms, are based on self-reported data, which may introduce subjective or response biases. Third, this study excluded missing data on variables such as sarcopenia, ADL, and cognitive functions, which reduced the sample size. This may limit the generalizability of the findings to other older adult populations and compromise the representativeness of the sample. Finally, the study variables are constrained by the data collection methods and questionnaire design of CHARLS, which may lead to unobserved confounding factors.

Conclusion

This study used mediation effect analysis to explore the relationship between sarcopenia, ADL, and mental health status in older adults. The results of the study showed a significant association between the severity of sarcopenia and the mental health of older adults. Sarcopenia was positively associated with depressive symptoms and negatively associated with cognitive functions, while ADL mediated the relationship between sarcopenia and mental health status. These associations provide potential avenues for future interventions and treatments targeting these health issues.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12877-025-05723-0.

Supplementary Material 1

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Author contributions

HG was involved in the writing, data analysis, and revision of the article; SY, WG, WS, and SD conceptualized the writing framework of the article; WC, HJ, and SJ were involved in data cleaning and literature search; SY, SJ, and WS provided suggestions for the analysis and interpretation of the study; and GM and DQ made significant contributions to the writing, revision, and review of the article. All authors agreed to contribute to the journal and are responsible for all aspects of the work.

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Data availability

The data were obtained from the publicly available database of the China Health and Retirement Longitudinal Study, which is available for free download at https://charls.charlsdata.com/pages/data/111/zh-cn.html.

Declarations

Ethics approval and consent to participate

This study adhered to the principles of the Declaration of Helsinki and was reviewed and approved by the Ethical Review Committee of Peking University (IRB00001052-11015). Informed consent was obtained from all participants before their inclusion in the study.

Consent for publication

Not applicable.

Clinical trial number
Not applicable.

Competing interests
The authors declare no competing interests.

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