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Sarcopenia and mild cognitive impairment among elderly adults: The first longitudinal evidence from CHARLS

Yisong Hu[1], Wenjia Peng[2], Rujing Ren[3], Ying Wang[2,4]* & Gang Wang[3]*

[1]*National Survey Research Center, Renmin University of China, Beijing, China;* [2]*School of Public Health, Fudan University, Shanghai, China;* [3]*Department of Neurology and Institute of Neurology, Ruijin Hospital, Shanghai Jiao Tong University School of Medicine, Shanghai, China;* [4]*NHC Key Laboratory of Health Technology Assessment, Fudan University, Shanghai, China*

Abstract

Background The association between sarcopenia and mild cognitive impairment (MCI) among elderly adults in China remains unclear. The present study aimed to examine the association based on a nationally representative large-scale survey.

Methods The study used two waves of data from China Health and Retirement Longitudinal Study (CHARLS) in 2015 and 2018. All subjects met the inclusion criteria were classified based on Asia Working Group for Sarcopenia 2019 criteria. Aging-associated cognitive decline is used to define MCI, and cognitive function is measured based on four dimensions: orientation, computation, memory, and drawing. OLS and logistic regression model were conducted to analyse the cross-sectional association between sarcopenia and different cognitive functions. Logistic regression model was conducted to analyse the longitudinal association between sarcopenia and MCI.

Results Totally, 5715 participants aged over 60 years (43.8% women; mean age 67.3 ± 6.0 years) were enrolled in a cross-sectional association study in 2015, and further 2982 elderly adults were followed up in 2018. During the period, sarcopenia and possible sarcopenia increased from 8.5% to 29.6%. Scores of cognitive and four dimensions (orientation, computation, memory, and drawing) exhibited a decreasing trend from non-sarcopenia to sarcopenia ($P < 0.001$). In the fully adjusted OLS regression model, scores of four dimensions were lower in possible sarcopenia and sarcopenia groups when compared with the non-sarcopenia group ($P < 0.05$) respectively. The incidence of MCI was 10.1%, 16.5%, and 24.2% for non-sarcopenia, possible sarcopenia, and sarcopenia groups from 2015 to 2018, with a significantly statistical difference ($P < 0.001$). Logistic regression model revealed an odds ratio of 1.43 [95% confidence interval (CI): 1.06–1.91, $P = 0.017$] for the possible sarcopenia group and 1.72 (95% CI: 1.04–2.85, $P = 0.035$) for sarcopenia group when compared with the non-sarcopenia group.

Conclusions Sarcopenia is associated with worse cognitive impairment, which provided new evidence for a strong association that warrants further research into mechanistic insights.

Keywords CHARLS; mild cognitive impairment; sarcopenia

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**Correspondence to: Gang Wang, Department of Neurology and Institute of Neurology, Ruijin Hospital Affiliated to Shanghai Jiao Tong University School of Medicine, Shanghai, China. Email: wg11424@rjh.com.cn*
Ying Wang, School of Public Health, NHC Key Laboratory of Health Technology Assessment, Fudan University, Shanghai, China. Email: wangying1013@fudan.edu.cn
Yisong Hu and Wenjia Peng contributed equally.
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Introduction

With the rapid development of China's society and economy, the aging of China's population is further deepened. According to the latest seventh population census in 2020, the population aged 60 and above in China is 264 018 766, accounting for 18.70% of the total population, among which the population aged 65 and above is 190 635 280, accounting for 13.50% of the total population.[1] A large-scale elderly population will greatly increase the burden of disease and medical care needs of the whole society. It is estimated the percentage of gross domestic product (GDP) spent on pensions, healthcare, welfare, and facilities will increase from 7.33% in 2015 to 26.24% in 2050.[2] Among many health-related factors leading to disability in the elderly, sarcopenia and cognitive impairment have received widespread attention in academic circles and clinics.

Sarcopenia is mainly defined by progressive and widespread skeletal muscle disease, including accelerated loss of muscle mass and function. However, there are challenges in clinical diagnostic approaches.[3] The occurrence of sarcopenia is related to age, nutritional intake, physical inactivity, disease, and iatrogenic factors.[4] Sarcopenia increases the risk of a variety of adverse events, including falls, reduced physical function, vulnerability, and death.[5] So far, many academic organizations including the European Working Group on Sarcopenia in Older People (EWGSOP),[4] the Asian Working Group for Sarcopenia (AWGS),[6] and the Foundation for the National Institutes of Health (FNIH)[7] have put forward the diagnostic criteria about sarcopenia. The prevalence of sarcopenia was estimated in different countries and regions based on the diagnostic criteria. A meta-analysis[8] suggested that the prevalence of sarcopenia among the elderly in Chinese communities was 12.9% in males and 11.2% in females and varied by diagnostic criteria and regions.

The fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) classified mild cognitive impairment (MCI) as mild neurocognitive impairment.[9] Specifically, it refers to the subjective and objective decline in the functional level of one or more cognitive dimensions compared with the past, but it does not seriously affect the daily instrumental activities and does not occur mental or other psychological diseases.[9] Studies have shown that MCI is associated with age, gender, apolipoprotein E allele, family history, and the presence of cardiovascular risk factors such as hypertension, hyperlipidaemia, coronary heart disease, and stroke.[10–12] Currently, the diagnostic criteria of MCI are not uniform. A meta-analysis[13] found that the prevalence of cognitive impairment among the Chinese elderly aged over 55 years was 15.4% and varied by the diagnostic criteria. Cognitive impairment was more likely to be experienced by women, the elderly, illiterates, people living in rural areas, and those with unhealthy lifestyle and comorbidities.

Given the common influencing factors between sarcopenia and cognitive impairment, studies have suggested a possible link between sarcopenia and cognitive impairment.[14] Currently available evidence[15–18] on the association between sarcopenia and cognitive impairment is based on cross-sectional data and needs to be verified by large-scale longitudinal studies. To fill the research gap, in this study, we used the nationally representative data from the China Health and Retirement Longitudinal Study (CHARLS), in conducting a cross-sectional analysis in 2015 at wave 3 to investigate the association between sarcopenia and cognitive function in Chinese elderly adults aged 60 years and above, and further analysing the longitudinal association of sarcopenia with MCI based on data in 2018 at wave 4, aiming to provide objective scientific evidence on aetiology, early intervention, and prevention strategies of MCI.

Methods

Study population

CHARLS project aims to collect a set of high-quality microdata representing households and individuals aged 45 and above in China to analyse the aging of China's population and promote interdisciplinary research on aging. CHARLS national baseline survey was conducted in 2011 using the multi-stage probability to proportional to size (PPS) sampling method. The samples covered 450 villages, 150 counties, and 28 provinces, involving more than 17 000 people from about 10 000 households. The CHARLS is an ongoing survey with exams performed every 2 to 3 years. The participants were interviewed face-to-face in their homes through computer-assisted personal interviewing (CAPI) technology. The survey included basic demographic information of the respondents and their families, transfer payments between family members, health status of the respondents, medical care and insurance, employment, income, expenditure and assets, and so on. Besides, CHARLS included 13 physical measurements and blood sample collection. To date, CHARLS has released four waves data of national baseline survey (wave 1, 2011y), the first follow-up survey (wave 2, 2013y), second follow-up survey (wave 3, 2015y), and third follow-up survey (wave 4, 2018y). The detailed information about CHARLS had been published in previous literature.[19] The CHARLS datasets can be downloaded at the CHARLS home page at http://charls.pku.edu.cn/en. The CHARLS survey project was approved by the Biomedical Ethics Committee of Peking University, and all participants were required to sign informed consent.

This study used data from two waves collected in 2015 (wave 3) and 2018 (wave 4), respectively. The sample size in wave 3 was 21 097. We excluded 15 382 individuals due

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to (1) no information on cognition, (2) no information on sarcopenia, and (3) age <60 years. The cross-sectional analysis included 5715 participants. In the longitudinal analysis, we excluded the participants with a cognitive score less than the threshold in wave 3[20,21] and missing information on cognitive in wave 4, which resulted in 2982 eligible individuals. The detailed flowchart of the sample selection process is shown in *Figure* 1.

Measurement of cognitive function

We measured the cognitive function based on the method used in the American Health and Retirement Study (HRS).[22] The participants received a face-to-face assessment from four cognitive function dimensions: orientation, memory, computation, and drawing. Orientation and computation were determined using the Telephone Interview for Cognitive Status (TICS). Items for orientation included year, month, day, the day of the week, and the current season. The total score of the orientation dimension is five points, with one point for each item. For computation, the participants were asked to successively subtract 7 from 100 for five times, with one point awarded for each successful operation. Ten words were randomly read to each participant, and the immediate word recall was assessed by counting how many words could be recalled immediately. Delayed word recall was evaluated after the participant completed the survey of depression scale, computation, and drawing tests. The total score of memory, defined as the sum scores of immediate and delayed word recall, was 20 points, with one point for each word. The interviewer showed a picture of two pentacle stars overlapping each other to check whether the participant could draw them appropriately to test their drawing ability. If correct, the participant scored one point. The total score of cognitive was defined as the sum scores of orientation (5 points), computation (5 points), memory (20 points), and drawing (1 point), resulting in 31 points.[23]

There is no consensus on the diagnostic criteria of MCI. In our study, we used aging-associated cognitive decline (AACD) to define MCI, namely, at least 1 standard deviation (SD) below the age standard.[20,21] All participants over 60 years old were grouped for every 5 years of age. The participant in each age group who met the AACD criteria would be classified as MCI. In longitudinal analysis, participants with MCI at baseline (wave 3, n = 958) were excluded from longitudinal analysis. Three hundred seventy-three new MCI cases were diagnosed during the follow-up.

Assessment of sarcopenia

Sarcopenia was assessed based on the criteria recommended by the AWGS2019,[24] including muscle strength, appendicular skeletal muscle mass (ASM), and physical performance. Handgrip strength (unit: kg) was measured in the dominant hand and non-dominant hand, with the participant squeezing a YuejianTM WL-1000 dynamometer as hard as possible. Each participant was tested in duplicate for both hands by holding the dynamometer at a right angle (90°). The average of the available maximum strength data was used. If one of the participant's hands could not be measured for some reason, the maximum value with the other hand was recorded. According to AWGS 2019, the cut-off point for low handgrip strength was defined as less than 28 kg for men and less than 18 kg for women. ASM for the Chinese population was estimated

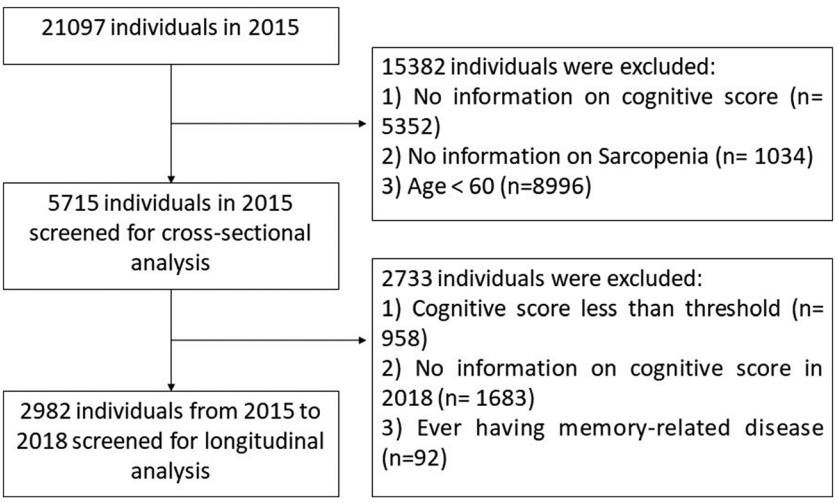

Figure 1 Flowchart of the sample selection process.

using a physical measurement formula reported by a previous study[25]:

$$\begin{aligned}\text{ASM} = {} & 0.193 \times \text{weight (kg)} + 0.107 \times \text{height (cm)} \\ & - 4.157 \times \text{gender} - 0.037 \times \text{age (years)} - 2.631\end{aligned}$$

where the weight was measured by OmronTM HN-286 scale and the height was measured by SecaTM213 height meter. If male, gender was set to 1, otherwise to 0. Several studies have shown that ASM calculated by this formula is in good agreement with dual-energy X-ray absorptiometry (DXA).[25,26] Similar to previous studies,[27] the cut-off for low muscle mass was based on the sex-specific lowest 20% of the height-adjusted muscle mass (ASM/height^2) among the study population, with $<$4.89 kg/m^2 in women and $<$6.79 kg/m^2 in men.

Physical performance included the gait speed, the five-time chair stand test, and the short physical performance battery (SPPB). For gait speed, each participant was asked to walk a 2.5-m distance at a normal pace two times (there and back). The time to complete was recorded. The five-time chair stand test measures the amount of time needed for the participants to rise continuously five times keeping their arms folded across their chest from the height of the 47-cm chair. In addition to the previous gait speed and the five-time chair stand test, the assessment of SPPB also included three-position tests for 10 s each: (1) a side-by-side position; (2) semi-tandem position (the heel of one foot beside the big toe of the other foot); and (3) tandem position (the heel of one foot in front of and touching the toes of the other foot). The total score of SPPB was 12 points with 4 points for each test. According to the AWGS 2019 recommendations, low physical performance was defined as a gait speed on $<$1.0 m/s, 5-time chair stand test $\geq$12 s, or SPPB score $<$9.

Possible sarcopenia is defined as low muscle strength or low physical performance. Sarcopenia is defined as low muscle mass plus low muscle strength or combined low physical performance. Therefore, all participants were divided into three groups: non-sarcopenia, possible sarcopenia, and sarcopenia.

Potential covariates

According to prior knowledge, we also considered sociodemographic characteristics and health-related factors in our study. Sociodemographic characteristics included age, gender, residential area (urban and rural), education (illiterate, primary school, middle school, high school/vocational high school, and junior college or above), average household income ($<$1000, 1000, 5000, 10 000, and 20 000 Chinese Yuan), marital status (married, separated, and unmarried/divorced/widowed). Health-related factors included ever/current smoke, ever/current alcohol, daily sleep time, and 14 common co-morbidities (cancer, chronic lung diseases, heart disease, stroke, emotional and mental disorders, arthritis, dyslipidaemia, hepatic disease, kidney disease, digestive system disease, asthma, memory-related disease, hypertension, and hyperglycaemia). Body mass index (BMI) was defined as the weight (unit: kg) divided by the square of height (unit: m). Depression was assessed by the 10-item Center for Epidemiologic Studies Depression Scale (CESD-10), with 30 of the total scores.

Statistical analysis

Quantitative data with normal distribution were described as mean and SD, and differences among three groups (non-sarcopenia, possible sarcopenia, and sarcopenia) were compared using one-way ANOVA. Qualitative data were reported using percentages, and differences among groups were compared using the χ^2 test.

OLS regression model was adopted to investigate the cross-sectional association between scores of total cognitive function and three dimensions (orientation, memory, and computation) and sarcopenia in 2015, expressed in regression coefficients (β) and 95% confidence intervals (CIs), while the association between drawing dimension and sarcopenia was analysed using a logistic regression model, expressed in odds ratios (ORs) and 95% CIs. We also used a logistic regression model to analyse the relationship between sarcopenia and the occurrence of MCI based on longitudinal data from 2015 and 2018. We used different combinations of covariates in five models. More specifically, model 1 included only cognitive function; model 2 included age, gender, residential area, education, average household income, and marital status; model 3 additionally included ever/current smoke, ever/current alcohol, and daily sleep time; model 4 additionally included co-morbidities and CESD score; and model 5 included BMI. All statistical analyses were conducted using STATA 16.0 software, and the significance level of statistical tests was 0.05.

Results

Table 1 presented the baseline characteristics of the study population in wave 3. The average age of the 5715 participants was 67.3 years (SD: 6.0 years), and 56.2% of the participants were male. Based on AWGS criteria, 486 (8.5%) and 1689 (29.6%) participants were diagnosed with sarcopenia and possible sarcopenia, respectively. Sarcopenia individuals were more likely to be more advanced age, rural residents, lower education, lower average household income, and more unmarried/divorced/widowed. The distribution of co-morbidities among non-sarcopenia, possible sarcopenia,

Table 1 Baseline characteristics of study population in wave 3

Variables	Total	Non- sarcopenia	Possible sarcopenia	Sarcopenia	*P*-value
Age (years, M ± SD)	67.3 ± 6.0	66.0 ± 5.1	68.7 ± 6.3	72.5 ± 6.6	<0.001
Gender					
Male	56.2	58.4	50.9	58.9	<0.001
Female	43.8	41.6	49.1	41.1	
Residential area					
Urban	41.6	44.6	40.6	23.5	<0.001
Rural	58.4	55.4	59.4	76.5	
Education					
Illiterate	44.5	40.4	49.9	55.4	<0.001
Primary school	30.2	31.0	28.5	30.0	
Middle school	16.9	18.5	15.6	9.7	
High school/vocational high school	6.7	8.2	4.5	3.9	
Junior college or above	1.7	1.9	1.4	1.0	
Average household income (CNY)					
<1000	24.1	22.7	24.4	33.5	<0.001
1000	28.8	26.1	32.8	34.8	
5000	12.0	12.3	11.7	11.1	
10 000	15.0	16.1	13.3	12.7	
20 000	20.1	22.8	17.8	7.9	
Marital status					
Married	80.2	84.0	75.5	69.3	<0.001
separated	2.9	3.1	2.9	1.7	
Unmarried/divorced/widowed	16.9	13.0	21.6	29.0	
Ever/current smoke					
No	48.3	48.0	51.0	40.1	<0.001
Yes	51.7	52.0	49.0	59.9	
Ever/current alcohol					
No	49.1	46.8	53.7	49.8	<0.001
Yes	50.9	53.2	46.3	50.2	
Daily sleep time (h)					
<6	24.6	22.0	29.1	28.8	<0.001
6	16.2	17.3	14.6	13.7	
7	17.2	18.5	15.1	15.2	
8	18.4	19.0	16.5	21.1	
9	23.6	23.4	24.6	21.1	
Co-morbidities					
Cancer	1.68	1.42	2.04	2.38	0.134
Chronic lung disease	17.5	14.9	19.9	28.0	<0.001
Heart disease	22.6	20.5	27.7	20.8	<0.001
Stroke	4.5	3.0	7.7	4.3	<0.001
Emotional and mental disorders	2.0	1.6	2.9	2.4	<0.001
Arthritis	46.6	43.2	53.5	46.9	<0.001
Dyslipidaemia	21.8	20.4	27.9	11.6	<0.001
Hepatic disease	6.8	6.8	7.0	6.3	0.892
Kidney disease	11.5	10.6	13.3	11.8	0.023
Digestive system disease	31.7	30.6	31.4	41.0	<0.001
Asthma	8.0	6.4	9.4	14.1	<0.001
Memory-related disease	3.5	2.5	5.2	4.4	<0.001
Hypertension	40.1	36.9	50.9	30.3	<0.001
Hyperglycaemia	12.0	10.8	16.4	5.5	<0.001
CESD score, M ± SD	8.0 ± 6.2	7.14 ± 5.8	9.2 ± 6.7	9.6 ± 6.8	<0.001
BMI (kg/m^2, M ± SD)	23.5 ± 3.7	23.6 ± 3.5	24.7 ± 3.3	18.7 ± 1.5	<0.001

Abbreviations: BMI, body mass index; CESD, Center for Epidemiologic Studies Depression; CNY, Chinese Yuan; M ± SD, mean ± standard deviation.

and sarcopenia groups was a statistical difference ($P < 0.05$), except for cancer and hepatic disease. Individuals with sarcopenia had higher CESD scores and lower BMI.

The mean score of total cognitive function, orientation, memory, computation, and drawing in the overall population was 14.4 ± 4.9, 3.9 ± 1.2, 6.2 ± 3.4, 3.6 ± 1.5, and 0.6 ± 0.5, respectively, which exhibited a decreasing trend from non-sarcopenia to sarcopenia group ($P < 0.001$) (*Table* 2).

Table 3 showed the cross-sectional association between sarcopenia and cognitive score at wave 2015. In the crude model, the total cognitive score of possible sarcopenia (β = −1.78, 95% CI: −2.06, −1.50) and sarcopenia (β = −3.44, 95% CI: −3.90, −2.98) was lower than that of non-sarcopenia. Compared with the non-sarcopenia group, possible sarcopenia showed low scores for orientation, memory, computation, and drawing dimensions, and even lower

Table 2 Cross-sectional association between sarcopenia and cognitive score in wave 3 (M ± SD)

Cognitive score	Total (n = 5715)	Non-sarcopenia (n = 3540)	Possible sarcopenia (n = 1689)	Sarcopenia (n = 486)	P-value
Total score	14.4 ± 4.9	15.3 ± 4.7	13.5 ± 4.9	11.8 ± 5.0	<0.001
Orientation	3.9 ± 1.2	4.0 ± 1.1	3.8 ± 1.3	3.5 ± 1.4	<0.001
Memory	6.2 ± 3.4	6.7 ± 3.4	5.7 ± 3.3	4.6 ± 3.3	<0.001
Computation	3.6 ± 1.5	3.8 ± 1.4	3.4 ± 1.6	3.2 ± 1.7	<0.001
Drawing	0.6 ± 0.5	0.7 ± 0.5	0.6 ± 0.5	0.5 ± 0.5	<0.001

Abbreviations: M ± SD, mean ± standard deviation.

Table 3 OLS or logistic regression model on sarcopenia and cognitive score

Cognitive score	Models	Non-sarcopenia	Possible sarcopenia		Sarcopenia	
			β (95% CI)	P-value	β (95% CI)	P-value
Total score	Model 1	Reference	−1.78 (−2.06, −1.50)	<0.001	−3.44 (−3.90, −2.98)	<0.001
	Model 2	Reference	−0.78 (−1.04, −0.53)	<0.001	−1.30 (−1.73, −0.88)	<0.001
	Model 3	Reference	−0.74 (−1.00, −0.49)	<0.001	−1.27 (−1.70, −0.85)	<0.001
	Model 4	Reference	−0.62 (−0.90, −0.34)	<0.001	−1.20 (−1.67, −0.74)	<0.001
	Model 5	Reference	−0.64 (−0.92, −0.36)	<0.001	−0.98 (−1.47, −0.50)	<0.001
Orientation	Model 1	Reference	−0.26 (−0.33, −0.19)	<0.001	−0.52 (−0.63, −0.40)	<0.001
	Model 2	Reference	−0.11 (−0.18, −0.04)	0.001	−0.22 (−0.33, −0.10)	<0.001
	Model 3	Reference	−0.10 (−0.17, −0.03)	0.003	−0.20 (−0.32, −0.09)	<0.001
	Model 4	Reference	−0.08 (−0.16, −0.01)	0.030	−0.19 (−0.32, −0.07)	0.002
	Model 5	Reference	−0.09 (−0.17, −0.02)	0.017	−0.14 (−0.27, −0.01)	0.038
Memory	Model 1	Reference	−1.05 (−1.25, −0.86)	<0.001	−2.10 (−2.42, −1.78)	<0.001
	Model 2	Reference	−0.47 (−0.66, −0.29)	<0.001	−0.72 (−1.03, −0.40)	<0.001
	Model 3	Reference	−0.45 (−0.64, −0.27)	<0.001	−0.70 (−1.02, −0.39)	<0.001
	Model 4	Reference	−0.38 (−0.58, −0.17)	<0.001	−0.71 (−1.05, −0.36)	<0.001
	Model 5	Reference	−0.39 (−0.60, −0.18)	<0.001	−0.60 (−0.97, −0.24)	0.001
Computation	Model 1	Reference	−0.36 (−0.45, −0.27)	<0.001	−0.61 (−0.76, −0.47)	<0.001
	Model 2	Reference	−0.16 (−0.24, −0.08)	<0.001	−0.28 (−0.42, −0.14)	<0.001
	Model 3	Reference	−0.15 (−0.23, −0.07)	<0.001	−0.28 (−0.42, −0.14)	<0.001
	Model 4	Reference	−0.13 (−0.22, −0.04)	0.006	−0.22 (−0.38, −0.07)	0.005
	Model 5	Reference	−0.13 (−0.22, −0.04)	0.006	−0.17 (−0.33, −0.01)	0.040
Drawing*	Model 1	Reference	−0.47 (−0.59, −0.35)	<0.001	−0.88 (−1.07, −0.68)	<0.001
	Model 2	Reference	−0.20 (−0.34, −0.07)	0.003	−0.40 (−0.63, −0.18)	<0.001
	Model 3	Reference	−0.19 (−0.33, −0.06)	0.005	−0.40 (−0.62, −0.18)	<0.001
	Model 4	Reference	−0.15 (−0.30, −0.00)	0.044	−0.38 (−0.62, −0.13)	0.003
	Model 5	Reference	−0.16 (−0.31, −0.01)	0.041	−0.33 (−0.59, −0.07)	0.014

Notes: Model 1: No adjustment; Model 2: Adjusted for age, gender, residential area, education, average household income, and marital status; Model 3: model 2 + ever/current smoke, ever/current alcohol, and daily sleep time; Model 4: model 3 + co-morbidities and CESD score; Model 5: model 4 + BMI.
*Logistic regression model.

scores were observed in the sarcopenia group. In the fully adjusted model by age, gender, residential area, education, average household income, marital status, ever/current smoke, ever/current alcohol, daily sleep time, co-morbidities, CESD score, and BMI, similar patterns were also observed with statistical significance (all $P < 0.05$).

Out of 2982 longitudinal analytic samples, 373 participants (12.5%) developed into new-onset MCI at wave 4. The incidence of MCI in non-sarcopenia, possible sarcopenia, and sarcopenia groups was 10.1%, 16.5%, and 24.2%, respectively, with statistical significance ($P < 0.001$) (*Figure* 2). *Table* 4 showed the longitudinal association between sarcopenia and MCI based on logistic regression models. In the crude model, compared with the non-sarcopenia group, the risk of the occurrence of MCI for individuals with possible sarcopenia was higher (OR = 1.75, 95% CI: 1.38–2.23), and even higher in the sarcopenia group (OR = 2.85, 95% CI: 1.94–4.18). In the fully adjusted model by age, gender, residential area, education, average household income, marital status, ever/current smoke, ever/current alcohol, daily sleep time, co-morbidities, CESD score, and BMI, similar patterns were also observed with statistical significance (all $P < 0.05$).

Discussion

To the best of our knowledge, this is the first study to examine the longitudinal association between sarcopenia and cognitive impairment among the elderly population aged over

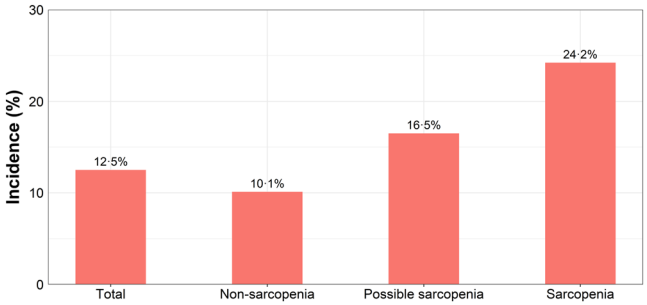

Figure 2 Prevalence of MCI in different groups.

Table 4 Longitudinal analysis on sarcopenia and MCI based on wave 3 and wave 4

Models	Non-sarcopenia	Possible sarcopenia		Sarcopenia	
		OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Model 1	Reference	1.75 (1.38, 2.23)	<0.001	2.85 (1.94, 4.18)	<0.001
Model 2	Reference	1.54 (1.19, 1.99)	0.001	2.16 (1.42, 3.30)	<0.001
Model 3	Reference	1.52 (1.18, 1.97)	0.001	2.18 (1.42, 3.34)	<0.001
Model 4	Reference	1.46 (1.09, 1.94)	0.010	1.89 (1.18, 3.05)	0.009
Model 5	Reference	1.43 (1.06, 1.91)	0.017	1.72 (1.04, 2.86)	0.035

Notes: Model 1: No adjustment; Model 2: Adjusted for age, gender, residential area, education, average household income, and marital status; Model 3: model 2 + ever/current smoke, ever/current alcohol, and daily sleep time; Model 4: model 3 + co-morbidities and CESD score; Model 5: model 4 + BMI.

60 years in Chinese communities using the nationally representative data. In a cross-sectional analysis, we found a negative association between sarcopenia and cognitive scores. Further, the elderly with possible sarcopenia or sarcopenia were more likely to develop new-onset MCI in a longitudinal analysis.

The cross-sectional analysis found a negative association between sarcopenia and cognitive scores. The elderly with sarcopenia had lower cognitive scores than those with non-sarcopenia. Our results were consistent with several cross-sectional studies[16–18] and meta-analyses.[14,15] However, the etiological association between sarcopenia and cognitive impairment requires further longitudinal data. The longitudinal analysis based on nationally representative data suggested that sarcopenia was an independent influence factor associated with MCI. Individuals with sarcopenia were 1.72 times more likely to develop MCI than those without sarcopenia in the fully adjusted model. The exact mechanisms of sarcopenia involved in MCI remained unclear. It was suspected that both of them shared common risk factors, including physical inactivity and malnutrition. Meta-analysis indicated that physical activity could not only reduce the onset of sarcopenia[28] but also delay cognitive decline.[29] One possible explanation was that cytokines and peptides secreted by skeletal muscle could enhance the function of the brain, including cognitive ability, suggesting a muscle-brain dialogue.[30] Poor nutrition might be due to inadequate dietary intake of nutrients that were common influence factors to sarcopenia and cognitive impairment.[31,32] In addition, physical activity and poor nutrition contributed to various chronic diseases, such as metabolic syndrome, which also increased the co-morbidities of sarcopenia and cognitive impairment.[33,34]

Based on AWGS 2019 criteria, we also analyse the influence of possible sarcopenia on cognitive function to facilitate early prevention interventions. A cross-sectional association suggested that the elderly with possible sarcopenia had lower cognitive scores when compared with non-sarcopenia groups, which was consistent with one study in Korea.[35] Longitudinal analysis found that individuals with possible sarcopenia were 1.43 times more likely to develop MCI when compared with non-sarcopenia ones in the fully adjusted model, which implied a causality correlation between sarcopenia and MCI.

The results derived from the cross-sectional analysis in wave 3 found that possible sarcopenia and sarcopenia were both associated with the scores of total cognitive function and four sub-dimensions, namely, orientation, memory, computation, and drawing. The evaluation and measurement methods of cognitive function varied in different studies. Several studies suggested that sarcopenia was only associated with some specific dimensions. For example, the findings from a survey in Mexican adults showed that sarcopenia was associated with immediate verbal recall, delayed verbal recall, and semantic verbal fluency.[36] A cross-sectional study from the Brazil study suggested a correlation between sarcopenia and verbal fluency test.[37]

There are several strengths of this study. First, a nationally representative longitudinal survey for the Chinese elderly was employed, and the extrapolation of results was relatively high quality. Second, this is the first study to examine the association of sarcopenia with cognitive impairment in China based on cross-sectional and longitudinal analysis adjusting multiple confounders. Third, this study provided new evidence for the utility of AWGS 2019 criteria on the screening of sarcopenia, which was important for the prevention and early intervention of cognitive impairment.

Nevertheless, the limitations of this study must be acknowledged. First, although we have adjusted a set of potential confounders based on prior knowledge, some extra confounders were not considered in our study, such as physical activity and dietary intake. The results were based on an observational study, and recall bias was inevitable in a questionnaire survey. Second, gait speed was measured at a distance of 2.5-m instead of the 6-m standard one. However, one study[38] suggested that the measurement of gait speed by CHARLS in 2015 was consistent with the previous studies in China, indicating that distance did not influence the gait speed. Third, although the correlation between sarcopenia and cognitive impairment derived from longitudinal study achieved stronger than that of the cross-sectional study, we could not interpret the potential biological mechanisms. Therefore, further experimental studies are necessary to confirm this association.

In conclusion, this study suggested a correlation between sarcopenia and the occurrence of MCI in the Chinese elderly population aged 60 and above, providing new evidence for a causal relation. In the context of China's population aging rapidly, enhancing physical activity and nutrition intervention is a benefit for the prevention of sarcopenia, which further contributes to decreasing and delaying the development of MCI and dementia among the elderly. As a result, it is critical to reduce the burden of chronic disease and improve the quality of life for the elderly.

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Conflicts of interest

We declare no competing interests.

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