Frailty and sarcopenia in elderly non-dialysis patients with chronic kidney disease stage 3-5: a cross sectional study

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Abstract

Background

With the aging of the population, chronic kidney disease (CKD) and sarcopenia are the common diseases among the elderly. Non-dialysis patients with CKD account for a relatively high proportion, and the analysis of their general clinical characteristics has been more familiar. However, the study of sarcopenia in non-dialysis with CKD is not enough.

Methods

This is a cross sectional study. Non-dialysis patients with CKD stage 3–5 were continuously selected. Patients were divided into 3 groups based on the Fried scale, Non-frail group, Pre-frail group and Frail group. At the same time, muscle mass of the hospitalized patients was measured by dual-energy X-ray absorptiometry (DXA), and according to the test results, they were divided into sarcopenia and non-sarcopenia group. Baseline data and the measurement of the sarcopenia of the two groups were analyzed.

Results

A total of 102 elderly patients with chronic kidney disease stage 3–5 were continuously enrolled. There were 21 patients (20.6%) categorized as sarcopenia, 81 patients (79.4%) categorized as non-sarcopenia according to the measurement results of DXA. Frailty was assessed by the criteria of frailty phenotype, there were 13 patients of sarcopenia in the frail group, 6 patients of sarcopenia in the pre-frail group, and 2 patients of sarcopenia in the non-frail group, accounting for 31.7%, 20.0%, 6.5%, respectively. Moreover, the analysis of the related risk factors of sarcopenia showed that body mass index ($\text{BMI} \geq 23 \text{ kg/m}^2$) ($OR = 3.82$, 95% CI 1.33–10.97, $P = 0.013$), $\text{MNA-SF} \leq 11$ ($OR = 3.97$, 95% CI 1.08–14.58, $P = 0.038$) were the independent risk factors for sarcopenia in non-dialysis patients with chronic kidney disease stage 3–5.

Conclusions

The prevalence of sarcopenia in elderly non-dialysis patients with chronic kidney disease stage 3–5 was high, and sarcopenia was common in the frail patients. $\text{BMI} \geq 23 \text{ kg/m}^2$ and $\text{MNA-SF} \leq 11$ were the independent risk factors for sarcopenia in non-dialysis patients with chronic kidney disease stage 3–5.

Background

The global population is aging rapidly, this problem is particularly severe in China. According to the data from the National Bureau of Statistics of China, Chinese population aged 65 and over reached

176 million in 2019, and the number presents a trend of increasing. By contrast, the natural growth rate of population in the same year was 3.34‰, which is decreasing year by year (<http://data.stats.gov.cn/easyquery.htm?cn=C01>). With the aging of the population, age-related diseases have become a prominent problem. Chronic kidney disease and sarcopenia are the diseases with high incidence in the elderly.

With the growing of the age, the body composition changes accordingly, the loss of skeletal muscle mass is an important aspect of these changes [1]. Atrophy of muscle begins about 25 years old and thereafter accelerates, and leading to loss of muscle strength and function [2]. Sarcopenia is therefore an age-related degenerative syndrome characterized by varying degrees of loss of skeletal muscle mass, strength and function [3]. In older adults, this geriatric syndrome increases the risk of falls, loss of independence, disability, hospitalization, and death [4, 5].

Non-dialysis patients with CKD stage 3–5 account for a relatively high proportion, the research and early intervention of these patients may reverse the progression to end-stage renal disease, thus, it has important clinical significance. The general clinical characteristics of non-dialysis patients have been widely studied [6–8]. However, to the best of our knowledge, there are few studies on the analysis of sarcopenia in non-dialysis patients with CKD stage 3–5. Sarcopenia is a common disease in elderly patients. To analyze the characteristics of sarcopenia of CKD 3–5 non-dialysis patients is helpful to understand the characteristics of the disease and to control the disease.

The aim of this study was to explore the prevalence and characteristics of sarcopenia in elderly non-dialysis patients with CKD stage 3–5.

Methods

Study design and participants

This study was a cross-sectional investigation that recruited individuals aged 65 and older with CKD stage 3–5. The included patients were admitted to Beijing Chaoyang Hospital, Capital Medical University from March to October 2019. All the clinical data were collected by two systematically trained physicians, and then carefully collated it to ensure the accuracy of the data. Frailty and sarcopenia were assessed by a combination of face-to-face inquiry and field measurements.

All the enrolled patients were aged 65 and older with CKD stage 3–5 calculated by formula of Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) [9], namely, estimated glomerular filtration rate (eGFR) $\geq 60 \text{ mL} \cdot \text{min}^{-1} \cdot (1.73 \text{ m})^{-2}$. Exclusion criteria were as follows: (1) patients already on dialysis (both hemodialysis and peritoneal dialysis); (2) the survival period was less than one year (e.g., patients with the advanced tumor); (3) patients with communication difficulties (e.g., patients with severe cognitive impairment and patients with severe hearing impairment); (4) patients with acute myocardial infarction, acute pulmonary embolism, and gastrointestinal bleeding; (5) refusal to participate.

Assessment of sarcopenia

The criteria for sarcopenia established by the European Working Group on Sarcopenia in Older People (EWGSOP) (2010) was adopted[10]. For all subjects, grip strength was measured by electronic grip dynamometer (EH101, Zhongshan, China), the subjects' feet were naturally separated into an upright posture, and their arms were naturally hanging down. We asked the subjects to hold it with dominant hand for two times, and took the maximum value for analysis. In addition, all individuals' walking speed was measured. We marked the distance of 6 meters on the flat ground with a marker pen, the participants walked 6 meters from the stationary position using the daily walking speed. A stopwatch was used to measure the walking time and then we calculated the walking speed. For patients with grip strength less than 30 kg (males), less than 20 kg (females), and/or walking speed less than 0.8 m/s, the patients' appendicular skeletal muscle mass (ASM) was measured by dual-energy X-ray absorptiometry (DXA) (Prodigy primo, Mexico). Then skeletal muscle mass index (ASMI) was calculated, ASMI less than 7.26 kg/m² in males and 5.44 kg/m² in females was diagnosed as sarcopenia.

Data collection

The included patients' demographic information, clinical disease history and comprehensive geriatric assessment (CGA), frailty score were collected by two systematically trained physicians.

Demographic information: name, gender, age, height and weight, smoking and drinking, and the body mass index was calculated by the formula: BMI = height/weight². Systolic and diastolic blood pressure was measured with a sphygmomanometer for two consecutive times, and the mean value was recorded.

Clinical disease history

self-reported hypertension, diabetes, cerebrovascular disease, tumor, coronary heart disease, and chronic pulmonary disease. Current indexes of hematology were recorded, including hemoglobin, albumin, pre-albumin, etc.

Comprehensive geriatric assessment: to evaluate condition of polypharmacy, we calculated the number of medications, polypharmacy refers to the use of 5 or more drugs simultaneously[11]; to evaluate the functional status, we asked participants to fill out the Activity of Daily Living (ADL) and Instrumental Activity of Daily Living (IADL) questionnaire, ADL scores ≤ 6 or IADL scores ≤ 8 were considered as limited functional condition[12]; to evaluate the nutritional status, we asked patients to fill out the Mini Nutritional Assessment-Short Form (MNA-SF) questionnaire (12–14 points: well nourished; 8–11 points: at risk of malnutrition; 0–7 points: malnourished)[13]; to evaluate the cognitive function, we asked patients to fill out the Mini-Mental State Examination (MMSE) questionnaire, the score of MMSE range from 0 to 30 points, with higher scores indicating better cognitive function[14]; to assess the mental condition, we calculated the Geriatric Depression Scale (GDS) score, the score of GDS range from 0 to 30 points, with higher scores indicating better depression[15]; to assess the physical function, we calculated the Short

Physical Performance Battery (SPPB) score, in which a score ≤ 10 points is regarded as impaired physical function[16].

Assessment of frailty: in this study, frailty phenotype proposed by Fried et al. was used to evaluate frailty [17–18], then patients were divided into non-frail, pre-frail and frail. The frailty phenotype includes five aspects: (1) unintentional weight loss ≥ 4.5 kilograms or $\geq 5\%$ in the past 1 year; (2) exhaustion was evaluated according to the Center for Epidemiologic Studies Depression Scale (CES-D): one felt that everything required effort or could not walk forward for more than 3 days in the past 1 week was considered as exhaustion [17]; (3) weakness: grip strength less than a certain amount of kilograms based on sex and body mass index; (4) slowness: walking 4.57 meters for more than a certain amount of time based on sex and height; (5) low activity: energy expenditure per week of physical activity ≤ 383 kcal for males (about walking for 2.5 hours), ≤ 270 kcal for females (about walking for 2 hours)[17]. Meeting 3 or more criteria was defined as frail, meeting 1 or 2 criteria was defined as pre-frail and meeting 0 criteria was defined as non-frail.

Statistical analysis

Measurement data were tested for normality, the data conforming to the normal distribution such as BMI, SBP, DBP, hemoglobin, albumin were represented by mean $\pm$ standard deviation, the data that did not conform to the normal distribution such as age, pre-albumin and eGFR were represented by $M(1/4, 3/4)$. Student's *t*-test and non-parametric Wilcoxon test were used for comparison between groups. Enumeration data such as sex, smoking, drinking, polypharmacy were expressed as *n* (%), and Chi-Square analysis was used for comparison between groups. A stratified analysis of age, BMI, MNA-SF, Fried score, ADL score, SPPB score, albumin, pre-albumin, eGFR was conducted, with a *P*-value ≤ 0.20 in the univariate analysis was included in the multivariate Logistic regression analysis. A multivariate confounding variables adjusted (age, BMI, MNA-SF, Fried score, ADL score, SPPB score, albumin, pre-albumin, eGFR) logistic regression analysis was used to analyze the related factors of sarcopenia in elderly patients, the odds ratio (OR) was used to indicate an increased risk of sarcopenia.

All data were statistically analyzed using SPSS 23.0, all figures were made by bilateral *P* ≤ 0.05 was considered statistically significant.

Results

Baseline characteristics

A total of 102 patients admitted to the Beijing Chaoyang Hospital, Capital Medical University from March to December 2019 were included in this study, including 57 males (55.9%) and 45 females (44.1%), and the average age was 76(67,83) years. According to the criteria of EWGSOP, subjects were categorized as two groups, sarcopenia group and non-sarcopenia group, there were 21 patients (20.6%) in the sarcopenia group, 81 patients (79.4%) in the non-sarcopenia group. There were significant differences in age, BMI, MFA-SF score and frailty score among the groups (*P* ≤ 0.05). The sarcopenia group was older, had

a lower BMI than the group of non-sarcopenia, in addition, we found a lower score of MNA-SF and a higher score of frailty in the non-sarcopenia group. However, there was no statistical difference in sex, blood pressure, blood indicators of hemoglobin, albumin, pre-albumin and eGFR, smoking, drinking, polypharmacy, ADL, IADL, GDS, SPPB, MMSE and hypertension, diabetes, coronary heart disease, cerebrovascular disease, tumor, and chronic pulmonary disease ($P \geq 0.05$). The comparison of baseline data was shown in Table 1.

Table 1
Comparison of general information of sarcopenia, non-sarcopenia group

Variable	Non-sarcopenia (<i>n</i> = 81)	Sarcopenia (<i>n</i> = 21)	<i>P</i>
Age,(years)	74.0(67.0,80.5)	81.0(72.5,84.5)	0.022
Male, n(%)	45(55.6)	12(57.1)	0.896
BMI(kg/m ²)	26.2 ± 3.9	23.5 ± 2.9	0.004
SBP(mmHg)	139.8 ± 17.2	144.8 ± 14.6	0.228
DBP(mmHg)	72.0 ± 7.1	70.2 ± 10.0	0.353
Hemoglobin(g/L)	118.0 ± 18.0	113.0 ± 19.2	0.264
Albumin(g/L)	38.6 ± 4.6	37.2 ± 2.5	0.182
Pre-albumin(g/L)	0.23(0.20,0.26)	0.20(0.18,0.24)	0.065
eGFR[mL·min ⁻¹ ·(1.73 m) ⁻²]	52.1(41.6,56.7)	47.6(34.9,54.1)	0.159
Smoking ,n(%)	17(21.0)	2(9.5)	0.229
Drinking ,n(%)	16(19.8)	1(4.8)	0.100
Polypharmacy, n(%)	56(69.1)	12(57.1)	0.299
ADL	5.0(4.0,6.0)	5.0(4.0,5.0)	0.113
IADL	6.0(4.0,8.0)	7.0(3.0,7.5)	0.660
MNA-SF	12.0(11.5,13.0)	11.0(10.5,12.0)	0.008
GDS	7.0(6.0,8.0)	7.0(6.0,9.0)	0.463
MMSE	26.0(25.0,27.0)	26.0(24.0,27.0)	0.241
SPPB	9.0(7.0,10.0)	8.0(6.5,9.0)	0.171
Frailty score	2.0(0.0,4.0)	3.0(1.5,4.0)	0.028
Hypertension ,n(%)	67(82.7)	17(81.0)	0.850
Diabetes mellitus ,n(%)	51(63.0)	10(47.6)	0.201
Coronary heart disease ,n(%)	22(27.2)	5(23.8)	0.756
Cerebrovascular disease ,n(%)	21(25.9)	7(33.3)	0.498

BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; eGFR, estimated glomerular filtration rate; ADL, activity of daily living; IADL, instrumental activity of daily living; MNA-SF, mini-nutritional assessment short form; GDS, geriatric depression scale; MMSE, mini-mental state examination; SPPB, short physical performance battery.

Variable	Non-sarcopenia (<i>n</i> = 81)	Sarcopenia (<i>n</i> = 21)	<i>P</i>
Tumor , <i>n</i> (%)	7(8.6)	1(4.8)	0.556
Chronic pulmonary disease , <i>n</i> (%)	11(13.6)	2(9.5)	0.619
BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; eGFR, estimated glomerular filtration rate; ADL, activity of daily living; IADL, instrumental activity of daily living; MNA-SF, mini-nutritional assessment short form; GDS, geriatric depression scale; MMSE, mini-mental state examination; SPPB, short physical performance battery.			

Frailty and sarcopenia

According to the criteria of frailty phenotype, 40.2% of patients were classified as frail, 29.4% as pre-frail and 30.4% as non-frail. There were 13 patients of sarcopenia in the frail group, accounting for 31.7%; 6 patients of sarcopenia in the pre-frail group, accounting for 20.0%; 2 patients of sarcopenia in the non-frail group, accounting for 6.5%. With the development of the state of frailty, the proportion of patients with sarcopenia also increases gradually. Compared with non-frail group, more individuals with sarcopenia were found in the frail group ($\chi^2=6.827, P= 0.009$), as shown in Fig. 1.

In total, 20.6% of patients were classified as sarcopenia, 79.4% as non-sarcopenia in this study. There were 13 patients of frailty in the sarcopenia group, accounting for 61.9%; 28 patients of frailty in the non-sarcopenia group, accounting for 34.6%. The proportion of patients with frailty was higher in the sarcopenia group. Compared with non-sarcopenia, more patients were found in the group of sarcopenia ($\chi^2=5.184, P= 0.023$), as shown in Fig. 2.

Risk factors of sarcopenia

A stratified analysis of age, BMI, MNA-SF, Fried score, ADL score, SPPB score, albumin, pre-albumin, eGFR was conducted, these factors with a *P*-value ≤ 0.20 in the univariate analysis. The multinomial logistic regression of sarcopenia was shown in Table 2. In the crude model, age 75–84 years old (*OR* = 3.55, 95% *CI* / 1.11–11.39), BMI ≥ 23 kg/m² (*OR* = 3.69, 95% *CI* / 1.34–10.20), MNA-SF ≤ 11 (*OR* = 4.07, 95% *CI* / 1.50–11.07), frailty score ≥ 3 (*OR* = 3.08, 95% *CI* / 1.14–8.30), pre-albumin ≤ 0.20 g/L (*OR* = 2.77, 95% *CI* / 1.03–7.49) was associated with sarcopenia. After adjusting for confounding variables, the multivariate logistic regression analysis showed that BMI ≥ 23 kg/m² (*OR* = 3.82, 95% *CI* / 1.33–10.97), MNA-SF ≤ 11 (*OR* = 3.97, 95% *CI* / 1.08–14.58) were still independently associated with sarcopenia.

Table 2
Multinomial logistic regression model for factors associated with sarcopenia

Factors	Crude Model			Adjusted Model		
	<i>OR</i>	<i>95%CI</i>	<i>P</i>	<i>OR</i>	<i>95%CI</i>	<i>P</i>
Age						
65–74(Ref)	1.00	1.00	—	1.00	1.00	—
75–84	3.55	1.11–11.39	0.033	3.00	0.57–15.83	0.196
≥ 85	3.23	3.23–0.81	0.097	3.23	0.44–23.45	0.247
BMI						
≥ 23(Ref)	1.00	1.00	—	1.00	1.00	—
≤23	3.69	1.34–10.20	0.012	3.82	1.33–10.97	0.013
MNA-SF						
≥11(Ref)	1.00	1.00	—	1.00	1.00	—
≤ 11	4.07	1.50–11.07	0.006	3.97	1.08–14.58	0.038
Frailty score						
≥3(Ref)	1.00	1.00	—	1.00	1.00	—
≥ 3	3.08	1.14–8.30	0.027	1.68	0.33–8.65	0.537
ADL score						
≥ 6(Ref)	1.00	1.00	—	1.00	1.00	—
≤6	2.69	0.90–8.05	0.076	1.13	0.20–6.24	0.890
SPPB score						
≥ 10(Ref)	1.00	1.00	—	1.00	1.00	—
≤10	2.01	0.61–6.57	0.248	1.47	0.27–8.01	0.655
Albumin						
≥ 40.0(Ref)	1.00	1.00	—	1.00	1.00	—
≤40.0	3.07	0.95–9.96	0.061	2.46	0.54–11.13	0.242
Pre-albumin						
≥ 0.20(Ref)	1.00	1.00	—	1.00	1.00	—

BMI, body mass index; eGFR, estimated glomerular filtration rate; ADL, activity of daily living; MNA-SF, mini-nutritional assessment short form; SPPB, short physical performance battery.

Factors	Crude Model			Adjusted Model		
	<i>OR</i>	<i>95%CI</i>	<i>P</i>	<i>OR</i>	<i>95%CI</i>	<i>P</i>
⊠0.20	2.77	1.03–7.49	0.044	2.43	0.67–8.80	0.176
eGFR						
45–59(Ref)	1.00	1.00	—	1.00	1.00	—
30–45	2.10	0.62–7.07	0.232	3.22	0.74–13.99	0.118
15–29	1.73	0.40–7.42	0.460	5.48	0.57–53.01	0.142
⊠15	—	—	0.999	—	—	0.999
BMI, body mass index; eGFR, estimated glomerular filtration rate; ADL, activity of daily living; MNA-SF, mini-nutritional assessment short form; SPPB, short physical performance battery.						

Discussion

This cross-sectional investigation found that the prevalence of sarcopenia among non-dialysis patients with CKD stage 3–5 was 20.6% according to the criteria of EWGSOP. Our study showed that the proportion of individuals of sarcopenia was high and consistent with those reported in some previous studies. For instance, Thomas et al. found a 19% prevalence of sarcopenia in a research involving British non-dialysis adults [19]. In Dutch patients, the prevalence of sarcopenia was 23.3% [20]. In contrast, the prevalence of sarcopenia was relatively higher in our study than some studies. In Japanese individuals, the prevalence of sarcopenia was 11.9% and 28.7% according to the criteria of the EWGSOP and the Foundation for the National Institutes of Health (FNIH) [21]. Raíssa et al. found a 9.8% prevalence of sarcopenia in Brazilian individuals [22]. Various factors, such as age, sex and race, can affect the measurement of muscle mass and thus lead to different prevalence of sarcopenia.

In our study, we investigated the proportion and relationship of sarcopenia and frailty in non-dialysis patients with CKD stage 3–5. Sarcopenia and frailty is common in CKD and there is a correlation between the two geriatric syndrome, they are all identified as vital risk factors for adverse events in individuals with non-dialysis CKD. Frailty is a state of various physiological related to age, involving nutritional status, social activities, cognitive function, psychological aspects, which makes the body's ability to combat stress decline[17, 23]. Our study found that the prevalence of frailty was 40.2%. A recent systematic review showed that the prevalence of frailty among dialysis patients was as high as 14–73% [24]. When it comes to non-dialysis patients, the prevalence of frailty was 20.9% according to the data from the Third National Health and Nutrition Evaluation Survey [25]. In our findings, the proportion of sarcopenia in the frail and pre-frail patients were 31.7% and 20.0%, respectively. Another cross-sectional study showed evidence for a link between sarcopenia and frailty, muscle density and muscle area ratio in patients with frailty syndrome was significantly lower than did non-frail individuals[26].

CKD is a chronic metabolic disease characterized by gradual loss of renal excretion and endocrine function, muscle wasting and decreased muscle endurance is common in the progression of the disease. Currently, numerous studies have investigated the pathogenesis of CKD-associated sarcopenia. Imbalances between protein degradation and synthesis, oxidative stress and inflammation[27], immobility, increased circulating glucocorticoids and angiotensin [28], hormonal dysregulation[29] are some of the reported pathogenesis of sarcopenia. Identifying the molecular mechanism of sarcopenia may promote the development of potential therapeutic means. Watson et al. have recently shown that progressive resistance exercise plays a vital role in increasing muscle cross-sectional area, muscle volume and muscle strength [30]. Yoshimura et al. have found that leucine-enriched amino acid is beneficial to the increase of muscle mass, muscle strength, and physical function[31]. In addition, blocking myostatin-ActRIIB signaling, dipeptidyl peptidase-4 inhibitor, L-carnitine have been proven to have the potential to treat CKD-associated sarcopenia[29].

We investigated the risk factors of sarcopenia in non-dialysis patients with CKD stage 3–5, the multivariate confounding variables adjusted logistic regression analysis showed that BMI ≥ 23 kg/m² and MNA-SF ≤ 11 were independently associated with sarcopenia. Our findings have some similarities with several studies, for instance, Lara et al. conducted a multicenter observational study in Italians whose age older than 65 years, they found a negative correlation between body mass index and the prevalence of sarcopenia[32]. Furthermore, in a current study, Hanan et al. showed that low BMI remained significantly related to mortality in sarcopenic patients after adjusting for sex and age[33]. However, a high body mass index is not advocated either. Obesity is regarded a vital reason of skeletal muscle loss that results in adipose tissue gain[34], when sarcopenia combined with obesity, we called sarcopenic obesity (SO)[35]. Elderly patients with sarcopenia obesity have higher rates of metabolic disease, cardiovascular disease, and increased risk of disability and death, not just these two diseases. Obese elderly people with low muscle mass have a higher risk of physical limitation than those with sarcopenia or obesity alone[36]. As for nutritional status, our results are consistent with previous studies which reported that malnutrition was one of the risk factors for sarcopenia. Vincenzo et al. found that malnutrition increased the incidence of sarcopenia in older adults, MNA-SF ($OR = 0.57$, 95% CI 0.34–0.96) was one of the related factors associated to sarcopenia[37]. Similarly, the risk of developing sarcopenia in elderly patients with poor nutritional status almost a fourfold increase according to a study conducted by Charlotte et al.[38].

This study has some limitations. Firstly, this study was a single-center, small sample observational study, the universality and applicability of the findings may be limited, and the sample size should be further expanded to increase the reliability of the results. Secondly, the conclusions of the study are derived from the cross-sectional study, and the causal association between sarcopenia and its related factors in elderly non-dialysis patients with CKD stage 3–5 cannot be verified, which need to be further confirmed by the cohort study.

Our study has some shining points. We analyzed the characteristics of sarcopenia of CKD 3–5 non-dialysis patients, involving more indicators in this observational study, which including general

information, comprehensive geriatric assessment, frailty status. This makes it possible for us to fully understand the characteristics of sarcopenia in non-dialysis patients, in addition, it provides a basis for further prevention and treatment of sarcopenia.

Conclusions

In conclusion, the present study shows that the prevalence of sarcopenia in elderly non-dialysis patients with chronic kidney disease stage 3–5 was high, and sarcopenia was common in the frail patients. Low BMI and MNA-SF ≤ 11 were the independent risk factors for sarcopenia in non-dialysis patients with chronic kidney disease stage 3–5.

Abbreviations

CKD: chronic kidney disease; DXA: dual-energy X-ray absorptiometry; CKD-EPI: Chronic Kidney Disease Epidemiology Collaboration; eGFR: estimated glomerular filtration rate; EWGSOP: European Working Group on Sarcopenia in Older People; ASM: appendicular skeletal muscle mass; ASMI: skeletal muscle mass index; CGA: geriatric comprehensive assessment; BMI: body mass index; SBP: systolic blood pressure; DBP: diastolic blood pressure; ADL: Activity of Daily Living; IADL: Instrumental Activity of Daily Living; MNA-SF: Mini Nutritional Assessment-Short Form; MMSE: Mini-Mental State Examination; GDS: Geriatric Depression Scale; SPPB: Short Physical Performance Battery; CES-D: Center for Epidemiologic Studies Depression Scale; SO: sarcopenic obesity; OR: odds ratio.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Beijing Chaoyang Hospital, Capital Medical University. All participants included in this study provided their written informed consent.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study available from the corresponding author on reasonable request.

Competing Interests

The authors declare that they have no competing interests.

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Not applicable.

Authors' contributions

JC and QS provided the conception and designed the study; YW, WH, YL and ZQ were in charge of data collection, statistical analysis and data interpretation; YW drafted the manuscript; JC and QS revised it critically. All authors read the final approved paper.

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Figures

Figure 1

The condition of sarcopenia in patients with different frail status. Compared with the non-frail group
 *P<0.01

Figure 2

The condition of frailty in patients with different sarcopenia status. Compared with the non-sarcopenia group, *P<0.05