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Prevalence of possible sarcopenia in community-dwelling older Chinese adults: a cross-sectional study

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Abstract

Objectives To determine the prevalence of possible sarcopenia and its association with other conditions in older adults in Bengbu, China.

Design, setting and participants A cross-sectional study of 1082 community-dwelling Chinese people aged at least 60 years from March to June, 2022.

Methods Handgrip strength and information regarding associated conditions were collected. Possible sarcopenia was estimated based on handgrip strength with cut-off values recommended by AWGS 2019. Mann-Whitney U tests, Chi-square tests and binary regression analyses were used to explore relationships between possible sarcopenia and associated conditions.

Results Possible sarcopenia was more prevalent in men (52.79%, n = 246, age 79.43 ± 7.33 years) than in women (44.48%, n = 274, age 78.90 ± 7.71 years). In men, possible sarcopenia positively correlated with age (odds ratio (OR) = 2.658, 95% CI 1.758-4.019), physical inactivity (OR = 2.779, 95% CI 1.646-4.691) and diabetes (OR = 4.269, 95% CI 2.397-7.602), and negatively with hypertension (OR = 0.586, 95% CI 0.384-0.893) and BMI (OR = 0.874, 95% CI 0.817-0.935). In women, possible sarcopenia positively correlated with age (OR = 3.821, 95% CI 2.677-5.455), physical inactivity (OR = 2.185, 95% CI 1.488-3.210) and arthritis (OR = 2.076, 95% CI 1.411-3.056).

Conclusion The prevalence of possible sarcopenia in older adults is high, and it is more common

among men than women. Men with high age, low BMI, physical inactivity, diabetes and no hypertension had a higher prevalence of possible sarcopenia; women with high age, physical inactivity and arthritis had a higher prevalence of possible sarcopenia.

Keywords Possible sarcopenia · Older people · AWGS · Handgrip strength

Strengths and limitations of this study

This study assessed possible sarcopenia using the latest guideline (AWGS 2019) and analyzed two subgroups based on gender. However, several limitations should be mentioned.

The findings may not be generalizable to other populations.

We did not investigate nutritional factors that may be related to possible sarcopenia.

Introduction

As an independent disease in the 10th edition of International Classification of Diseases, sarcopenia has become an important public health issue [1]. Sarcopenia is a geriatric syndrome characterized by loss of muscle mass and muscle strength and decreased physical function [2]. Substantial evidence suggests that sarcopenia has an important impact on the health of older adults, and it often is associated with adverse outcomes such as illness, falls, reduced quality of life and even death [3]. Sarcopenia is not only associated with aging, but it can also result from a combination of chronic diseases including respiratory disease [4], diabetes [5] and cancer [6]. It is associated with environmental factors, and the risk of developing sarcopenia can be lowered by changes to physical activity and diet [7 8].

In order to help predict the occurrence of sarcopenia in at-risk populations, the concept of "probable sarcopenia" was introduced in the guideline of the European Working Group on Sarcopenia in Older People (EWGSOP) in 2018. The guideline considered low muscle strength to be an indicator of probable sarcopenia [9]. In 2019, the Asia Working Group for Sarcopenia updated the guideline and proposed the concept of "possible sarcopenia", which was defined as the existence of low muscle strength with or without reduced physical performance [10]. Both guidelines recommend using handgrip strength to assess muscle strength, but there are slight differences in threshold values used for diagnosis [9 10].

The uses of these two international guidelines lead to differences in the reported prevalence of possible sarcopenia among different populations. One study determined that the prevalence of probable sarcopenia in a Colombian community was 46.5% based on threshold values from EWGSOP2 [11]. On the other hand, the values of the prevalence of probable sarcopenia in Swiss women and men were determined to be 26.3 and 28.0%, respectively [12]. In a South Korean study, Kim et al used the cut-off values recommended by the AWGS 2019 to screen for the possible sarcopenia and found a prevalence of 20.1% in men and a prevalence of 29.2% in women [13].

Despite renewed interest in the condition, no studies have been performed to investigate the possible sarcopenia and related factors in China. Therefore, the aims of this study were (1) to determine the prevalence of possible sarcopenia using the latest guideline (AWGS 2019) in a sample of older adults, aged 60 years and above, in Bengbu, China and (2) to explore the relationship between possible sarcopenia and its associated factors.

Methods

Sample

This was a cross-sectional, community-based study conducted in the city of Bengbu, China, from March, 2022, through June, 2022. Inclusion criteria for study participants were aged at least 60 years, ability to understand relevant issues and ability to provide informed consent. Exclusion criteria were inability to complete the handgrip strength measurement and lack of complete medical or demographic data.

The minimum sample size was calculated to be 792 elderly individuals, assuming a prevalence of possible sarcopenia of 24.6% [13], at a 3% error rate and 95% confidence interval. After considering the design effect as 1.5, the aim was to access a minimum sample size of 1188 individuals. Multi-stage random cluster sampling and random numbers table were conducted. First, all the streets were listed and 7 streets were randomly grouped. Then, 3 communities were randomly grouped into each street. Finally, citizens aged 60 and above were randomly selected from each community. As a result, the final sample included 1082 elderly participants for a 91.08% response rate (Figure 1). Each participant signed an informed consent form. The Ethics Committee of Bengbu Medical College approved the study protocol (Anhui, China; no.2018045).

Anthropometric measurements

All physical examinations were performed by trained medical students according to standardized procedures. Height and body weight were measured with a steel measuring tape and an electronic scale, respectively. Body mass index (BMI) was calculated as the square of the weight in kilograms divided by the height in meters. Waist circumference was measured from the middle point between the lower border of the rib cage and the iliac crest midaxillary at the end of a normal expiration with a soft measuring tape.

Assessment of possible sarcopenia

AWGS criteria (2019) define possible sarcopenia as the incidence of low muscle strength with or without reduced physical performance, therefore, in this study, low muscle strength was the only criterion used to define possible sarcopenia. Low muscle strength was defined as a handgrip strength of less than 28 kg in men and less than 18 kg in women. Handgrip strength was measured with an electronic hand dynamometer (EH101, https://www.senssun.com). Prior to use, the dynamometer was calibrated according to the manufacturer's instructions. Each participant was asked to hold the dynamometer with the dominant hand with as much force as possible for 3 s. This process was repeated three times with 30 s between each trial, and the handgrip strength was taken as the maximum value from these three trials.

Measurement of potential associated factors

Participants were sorted into two groups based on WHO age classification criteria: one group included participants that were aged 60 to 74 years and the other group included participants who were aged at least 75 years. Participants' level of physical activity was determined using self-reported values. According to the latest *World Health Organization 2020 Guidelines on Pactivity and Sedentary Behavior* [14], physical inactivity was defined as engagement in less than 150 minutes per week of moderate exercise, such as brisk walking, jogging or dancing (time of high intensity physical activity multiplied by 2 translates to time of moderate physical activity). Disease-related factors were assessed with a survey that asked the participants if they had been medically diagnosed with cancer, heart disease, hypertension, hyperlipidemia, diabetes, respiratory diseases, arthritis, or pain in the waist or lower extremities.

Statistical analysis

SPSS 25.0 software (IBM, Armonk, NY, USA) was utilized for data analyses. Continuous variables were expressed as mean ± SD. Categorical variables were expressed as frequencies and percentages. The normality of the variables was verified using Kolmogorov-Smirnov tests. The male and female samples were divided into two groups: no sarcopenia (normal handgrip strength) or possible sarcopenia (weak handgrip strength). Student's t-tests were applied to identify significant differences in normally distributed of continuous variables, while Mann-Whitney U tests were used for comparison of non-normal distributions of continuous variables between groups. The significance of differences in baseline characteristics were examined using chi-squared tests for categorical variables. Binary logistic regression was used to explore the relationship between each category of associated factors and possible sarcopenia.

Results

Data on handgrip strength and anthropometric measures were collected from 1,082 adults aged 60 years and over, (n = 466 men, n = 616 women; mean age 76.62 ± 7.11 years). Of the participants, 484 (44.73%) were aged from 60 to 74 years, and 598 (55.27%) were aged at least 75 years.

Possible sarcopenia was determined according to the AWGS 2019 guidelines with gender-specific handgrip strength cut-off values. Of the 466 male participants, possible sarcopenia was identified in 246 (52.79%). Of the 598 female participants, possible sarcopenia was identified in 274 (44.48%). In both men and women, the majority of participants identified as having possible sarcopenia are aged 75 years and over.

Height and weight were significantly lower in the possible sarcopenia group than in the no sarcopenia group (both $p < 0.05$). Among male participants, BMI was significantly lower in the possible sarcopenia group than in the group of no sarcopenia ($p < 0.05$), but there was no statistically significant difference in BMI among female participants ($p > 0.05$). Moreover, the possible sarcopenia group had a great number of participants who were classified as physically inactive (Table 1).

In male participants, older adults with possible sarcopenia were significantly more likely than those without possible sarcopenia to have developed diabetes (22.67% vs 11.82%; $p < 0.05$) and respiratory diseases (9.76% vs 3.64%; $p < 0.05$). Conversely, participants with possible sarcopenia were significantly less likely to have developed hypertension (45.93% vs 57.73%; $p < 0.05$). In female participants, older adults with possible sarcopenia were significantly more likely than those without possible sarcopenia to have developed arthritis (47.81% vs 30.41%; $p < 0.05$), and pain in the waist or lower extremities (61.68% vs 53.80%; $p < 0.05$) (Table 1).

Table 1 Characteristics of participants with or without possible sarcopenia

	Overall sample (n = 1082)	Men, n = 466 (43.07%)			Women, n=616 (56.93%)		
		Possible sarcopenia (n = 246; 52.79%)	No sarcopenia (n = 220; 47.21%)	*P* value	Possible sarcopenia (n = 274; 44.48%)	No sarcopenia (n =3 42; 55.52%)	*P* value
Age (years)	76.62 ± 7.11	79.43 ± 7.33	74.27 ± 4.92	< 0.001	78.90 ± 7.71	74.29 ± 6.31	< 0.001
Age group (n, %)							
60-74 years	484 (44.73)	78 (31.71)	122 (55.45)	< 0.001	82 (29.93)	202 (59.06)	< 0.001
≥ 75 years	598 (55.27)	168 (68.29)	98 (44.55)		192 (70.07)	140 (40.94)	
Height (cm)	158.31 ± 9.28	162.64 ± 6.39	166.11 ± 10.02	< 0.001	151.00 ± 6.92	156.04 ± 6.31	< 0.001
Weight (kg)	63.42 ± 12.27	64.61 ± 10.12	71.80 ± 10.14	< 0.001	56.96 ± 10.55	62.35 ± 12.95	< 0.001
WC (cm)	90.83 ± 9.95	91.26 ± 10.01	91.95 ± 7.92	0.204	89.83 ± 10.76	90.59 ± 10.35	0.553
handgrip strength (kg)	22.91 ± 8.57	21.49 ± 5.21	35.42 ± 5.11	< 0.001	13.85 ± 3.72	23.14 ± 4.13	< 0.001
BMI (kg/m²)	25.40 ± 6.75	24.42 ± 3.49	26.62 ± 11.42	< 0.001	25.00 ± 4.68	25.63 ± 5.72	0.428
Physical inactivity (n, %)	270 (24.95)	71 (28.86)	28 (12.73)	< 0.001	97 (35.40)	74 (21.64)	< 0.001
Cancer (n, %)	18 (1.66)	6 (2.44)	2 (0.91)	0.204	6 (2.19)	4 (1.17)	0.319
Heart diseases (n, %)	345 (31.89)	70 (28.45)	76 (34.55)	0.157	80 (29.20)	119 (34.80)	0.140
Hypertension (n, %)	599 (55.36)	113 (45.93)	127 (57.73)	0.011	170 (62.04)	189 (55.26)	0.090
Hyperlipidemia (n, %)	208 (19.22)	46 (18.70)	44 (20.00)	0.723	48 (17.52)	70 (20.47)	0.355
Diabetes (n, %)	201 (18.58)	56 (22.76)	26 (11.82)	0.002	54 (19.71)	65 (19.01)	0.836
Respiratory diseases (n, %)	93 (8.60)	24 (9.76)	8 (3.64)	0.009	32 (11.68)	29 (8.48)	0.186
Arthritis (n, %)	349 (32.26)	59 (23.98)	55 (25.00)	0.799	131 (47.81)	104 (30.41)	< 0.001
Pain in the waist or lower extremities (n, %)	534 (49.35)	93 (37.80)	89 (40.45)	0.499	169 (61.68)	184 (53.80)	0.049

WC waist circumference; *BMI* body mass index

For male participants, a binary logistic regression analysis showed that the significantly correlating variables age, BMI, physical inactivity, hypertension, diabetes and respiratory diseases explained whether a participant had possible sarcopenia or not to 65.9% (Nagelkerke's R2 = 0.236, Chi-squared (6) = 90.767, $p < 0.0001$). Higher age (Wald (1) = 21.478, $p < 0.0001$, OR = 2.658), physical inactivity (Wald (1) = 14.640, $p < 0.0001$, OR = 2.779) and diabetes (Wald (1) = 24.289, $p < 0.0001$, OR = 4.269) were risk factors for possible sarcopenia. Conversely, hypertension (Wald (1) = 6.174, $p = 0.013$, OR = 0.586) and higher BMI (Wald (1) = 15.378, $p < 0.0001$, OR = 0.874) were protective factors for possible sarcopenia. Respiratory disease did not have a significant association with possible sarcopenia (Table 2).

For female participants, a binary logistic regression analysis showed that the significantly correlating variables age, physical inactivity, arthritis and pain in lower extremities or waist explained whether a participant had possible sarcopenia or not to 67.4% (Nagelkerke's $R^2 = 0.185$, Chi-squared (4) = 91.593, $p < 0.0001$). Higher age (Wald (1) = 54.498, $p < 0.0001$, OR = 3.821), physical inactivity (Wald (1) = 15.874, $p < 0.0001$, OR = 2.185) and arthritis (Wald (1) = 13.733, $p < 0.0001$, OR = 2.076) were risk factors for possible sarcopenia. However, pain in the lower extremities or waist did not have a significant association with possible sarcopenia (Table 3).

Table2 Binary logistic regression analysis of possible sarcopenia category by correlated variables in men

Variables	Wald	Degrees of freedom	*P* value	Exp(B)/Odd's ratio	95%Confidence interval for Exp(B)	
					Lower	Upper
Age (≥75 years vs.60-74 years)	21.478	1	< 0.001	2.658	1.758	4.019
Physical inactivity (yes vs. no)	14.640	1	< 0.001	2.779	1.646	4.691
Hypertension (yes vs. no)	6.174	1	0.013	0.586	0.384	0.893
Diabetes (yes vs. no)	24.289	1	< 0.001	4.269	2.397	7.602
Respiratory diseases (yes vs. no)	2.659	1	0.103	2.169	0.855	5.501
BMI	15.378	1	< 0.001	0.874	0.817	0.935
Constant	9.647	1	0.002	14.990		

Table3 Binary logistic regression analysis of possible sarcopenia category by correlated variables in women

Variables	Wald	Degrees of freedom	*P* value	Exp(B)/Odd's ratio	95%Confidence interval for Exp(B)

					Lower	Upper
Age (≥75 years vs.60-74 years)	54.498	1	< 0.001	3.821	2.677	5.455
Physical inactivity (yes vs. no)	15.874	1	< 0.001	2.185	1.488	3.210
Arthritis (yes vs. no)	13.733	1	< 0.001	2.076	1.411	3.056
Pain in the waist or lower extremities (yes vs. no)	0.756	1	0.384	1.186	0.807	1.742
Constant	64.394	1	< 0.001	0.207		

Discussion

We investigated the prevalence of possible sarcopenia and its correlation with associated factors. We found that possible sarcopenia has a high prevalence in the community of Bengbu. The prevalence of 48.06% is similar to the prevalence found in adults in the same age group in a syudy confucted in Colombia [11]. However, that prevalence is higher than that found in the Asian country of South Korea [13]. The reason for this discrepancy may be that the South Korean study used the calf circumference (CC) and SARC/SARC-F scale to screen participants prior to administering the handgrip strength test, whereas the present study and the Columbian study used handgrip strength test directly to identify possible sarcopenia. This difference suggests that many of the older adults in South Korea who were not candidates for the handgrip strength test according to calf circumference and SARC/SARC-F scale criteria may have had lower handgrip strengths indicative of possible sarcopenia. Therefore, direct measurement of handgrip strength has important clinical value.

Our study found that possible sarcopenia is more common among men than women (52.77% in men and 44.48% in women), as did a study performed by Wearing et al [12] (28% in men and 26.3% in women). Interestingly, Pang et al [15] found that the prevalence of possible sarcopenia in men between the ages of 20 and 60 years (13%) is lower than that in women in the same age group (14.2%), but the relative prevalence in older adults over the age of 60 years is reversed (33.7% in men and 30.9% in women). A possible mechanism of pathogenesis of leading to differences in possible sarcopenia in men and women involves testosterone. Testosterone plays an important role in the development and maintenance of muscle mass and function and can increases muscle mass and muscle strength [16 17]. Testosterone in men declines at a rate of 1% per year after the age of 30, and 40 to 70% of men over the age of 70 have low testosterone levels [18]. This may be one of the important reasons why the prevalence rate of older men is higher than that of women. It should be noted that in the present study, the average age of male participants was significantly higher than that of female participants, which may have contributed to the higher prevalence rate among men than among women.

We found that age and physical inactivity might positively influence the prevalence of possible sarcopenia. The main cause of sarcopenia is muscle loss with age [19], and the incidence of possible sarcopenia increases with age [20]. Several studies have reported that physical inactivity is the primary risk factor for decreased muscle strength [21 22]. Tsekoura et al [23] and Makizako et al [24] confirmed that exercise intervention for older adults slows the decline of muscle strength with age. Nearly a quarter of the participants were physically inactive, which is another potential explanation for the high prevalence of possible sarcopenia observed in this study. The correlations of age and physical inactivity with possible sarcopenia suggests that encouraging more physical activity in older adults is particularly important to prevent or delay the onset and progression of sarcopenia.

The relationships of various factors to possible sarcopenia differed between the sexes. In men, diabetes was found to have a strong correlation with possible sarcopenia. Diabetes was associated with a 4.269-fold increase in the risk of possible sarcopenia in older men, but there was no correlation found in older women. Likewise, a longitudinal study in the United Kingdom showed an increase in probable sarcopenia after eight years in men with diabetes, but not in women [25]. However, Anagnostis et al [26] reported that the risk of sarcopenia had a slightly higher elevation by type 2 diabetes in men than in women, but the difference was not significant ($p = 0.08$). Thus, it is necessary to further investigate the existence of gender differences in the relationship between diabetes and possible sarcopenia.

We also found that hypertension is a protective factor for possible sarcopenia. Several studies showed that patients taking angiotensin converting enzyme inhibitors (ACEI) as therapy for hypertension had higher muscle strength than patients without hypertension and patients with hypertension who were not taking ACEI [27 28]. Similarly, Ata et al pointed that ACEI therapy seems to have favourable effects on both hypertension and sarcopenia [29]. Although more than half of the participants in our study were hypertensive, the medications they were taking were not investigated, so the relationship between hypertensive medications and possible sarcopenia will be further explored in later studies.

We also found that BMI is a protective factors for possible sarcopenia in men. Older adults with low BMI values may be underweight and at risk of malnutrition. From a pathophysiological point of view, both malnutrition and sarcopenia share an important component: a low-inflammatory state, a phenomenon that has been called inflamm-aging [8]. Therefore, early nutritional intervention for older patients with possible sarcopenia is an important strategy in decreasing the risk of progression to sarcopenia.

In our study, older adults with arthritis were found to have higher risk of sarcopenia in women. There are more than 100 types of arthritis. Rheumatoid arthritis (RA) is the most common form, but other common types of arthritis include osteoarthritis and inflammatory arthritis [30]. Several studies have shown that women are more likely to be diagnosed with RA than men [31-33], and adults with RA tend to have lower muscle masses or strengths compared to adults without RA [34-36]. Notably, RA can cause joint pain and deformity, therefore, it is unclear to what extent decreases in handgrip strength in patients with RA reflect true low muscle strength and how much of the limited handgrip strength may be secondary to pain or deformity [37]. Thence, other measurements should be considered to assess the possible sarcopenia in arthritis adults.

The major strength of our study is that it assessed possible sarcopenia using the latest guideline (AWGS 2019) and analyzed two subgroups based on gender. However, several limitations should be mentioned. First, this study focused solely on a population of older adults in Bengbu, so findings may not be generalizable to other populations. Second, we did not investigate nutritional factors that may be related to possible sarcopenia; a nutrition survey will be added in future studies.

Conclusions

The prevalence of possible sarcopenia in older adults in Bengbu is high, and it is more common among men than women. Men with high age, low BMI, physical inactivity, diabetes and no hypertension had a higher prevalence of possible sarcopenia; women with high age, physical inactivity and arthritis had a higher prevalence of possible sarcopenia. Community health care institutions should pay attention to the screening of possible sarcopenia, especially among older men. Targeted health education should also be carried out to encourage older adults to actively participate in physical exercise.

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Conflict of interest The authors have no conflicts of interest.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Ethics approval Ethical approval was obtained by the ethics committees of Bengbu Medical College (Anhui, China; no.2018045).

Statement of human participants and/or animals All the procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments.

Informed consent All individual participants in the research gave their informed consent.

Data availability statement The data are held at Physical fitness center of Bengbu Medical College.

Author contributions Jiaqin Yao: conceptualization, methodology, data collection, writing, investigation, statistical analysis. Yaoting Wang: data collection, methodology, writing, investigation. Lin Yang: data collection, writing. Mengting Ren: data collection, writing. Lingyan Li: writing. Hongyu Wang: conceptualization, methodology, statistical analysis.

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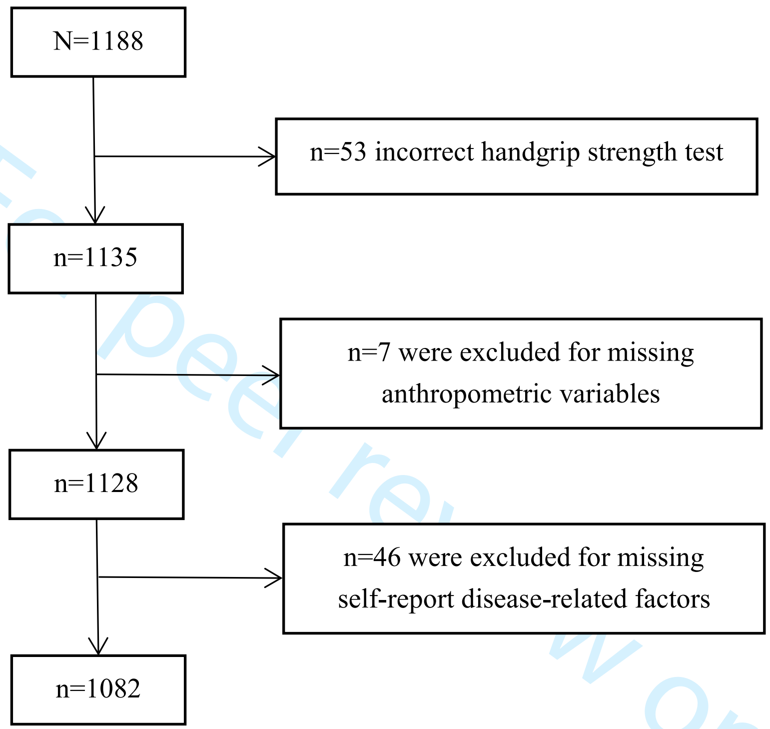

Figure 1 participation of elderly adults

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	#3	State specific objectives, including any prespecified hypotheses	3
Methods			

Study design	#4	Present key elements of study design early in the paper	3
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	3
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3-4
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	3-4
Bias	#9	Describe any efforts to address potential sources of bias	3(All physical examinations were performed by trained medical students according to standardized procedures.)
Study size	#10	Explain how the study size was arrived at	3
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	4-5
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	4-5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	4-5
Statistical methods	#12c	Explain how missing data were addressed	3(Figure 1)
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	3
Statistical	#12e	Describe any sensitivity analyses	4-5

methods

Results

Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	3
Participants	#13b	Give reasons for non-participation at each stage	3(Figure 1)
Participants	#13c	Consider use of a flow diagram	3(Figure 1)
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5-8
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	3(Figure 1)
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	5-8
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NO (The study did not adjust for confounding factors.)
Main results	#16b	Report category boundaries when continuous variables were categorized	3-4
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NO
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	6-8(The study was divided into two subgroups: men and women)

Discussion			
Key results	#18	Summarise key results with reference to study objectives	8-10
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	10
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	8-10
Generalisability	#21	Discuss the generalisability (external validity) of the study results	10
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	11

None This checklist can be completed online using https://www.goodreports.org/, a tool made by the EQUATOR Network in collaboration with Penelope.ai

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Prevalence of possible sarcopenia in community-dwelling older Chinese adults: a cross-sectional study

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Prevalence of possible sarcopenia in community-dwelling older Chinese adults: a cross-sectional study

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Abstract

Objectives To determine the prevalence of possible sarcopenia and its association with other conditions in older adults in Bengbu, China.

Design, setting and participants A cross-sectional study of 1082 community-dwelling Chinese people aged at least 60 years from March to June, 2022.

Methods Handgrip strength and information regarding associated conditions were collected. Possible sarcopenia was estimated based on handgrip strength with cut-off values (< 28 kg in men; < 18 kg in women) recommended by the Asia Working Group for Sarcopenia in 2019 (AWGS 2019). Mann-Whitney U tests, Chi-square tests and binary logistic regression analyses were used to explore relationships between possible sarcopenia and associated conditions.

Results Possible sarcopenia was more prevalent in men (52.79%, n = 246, age 79.43 ± 7.33 years among men with possible sarcopenia) than in women (44.48%, n = 274, age 78.90 ± 7.71 years among women with possible sarcopenia). In men, possible sarcopenia positively correlated with high age [odds ratio (OR) = 2.658, 95% confidence interval (CI) 1.758-4.019], physical inactivity (OR = 2.779, 95% CI 1.646-4.691) and diabetes (OR = 4.269, 95% CI 2.397-7.602), and negatively with hypertension (OR = 0.586, 95% CI 0.384-0.893). The risk of possible sarcopenia in men decreased by 12.6% for every 1 kg/m^2 increase of body mass index (BMI) (OR = 0.874, 95% CI 0.817-0.935). In women, possible sarcopenia positively correlated with high age (OR = 3.821, 95% CI 2.677-5.455), physical inactivity (OR = 2.185, 95% CI 1.488-3.210) and arthritis (OR = 2.076, 95% CI 1.411-3.056).

Conclusion Possible sarcopenia is prevalent in older adults and the factors affecting possible sarcopenia are different in men and women. Health education about these target factors can be considered as a potential measure to prevent possible sarcopenia.

Strengths and limitations of this study

⇒ This study used the concept of low handgrip strength (< 28 kg in men; < 18 kg in women) in the latest guideline (AWGS 2019) to assess possible sarcopenia.

⇒ The grouping of subjects by sex permitted additional insight into risk factors.

⇒ Because it was a cross-sectional study, cause-effect relationships could not be determined.

Introduction

As an independent disease in the 10th edition of International Classification of Diseases, sarcopenia has become an important public health issue [1]. Sarcopenia is a geriatric syndrome characterized by loss of muscle mass and muscle strength and decreased physical function [2]. Substantial evidence suggests that sarcopenia has an important impact on the health of older adults, and it often is associated with adverse outcomes such as illness, falls, reduced quality of life and even death [3]. Sarcopenia is not only associated with aging, but it can also result from a combination of chronic diseases including respiratory disease [4], diabetes [5] and cancer [6]. It is associated with environmental factors, and the risk of developing sarcopenia can be lowered by changes to physical activity and diet [7 8].

In order to help predict the occurrence of sarcopenia in at-risk populations, the concept of "probable sarcopenia" was introduced in the guideline of the European Working Group on Sarcopenia in Older People in 2018 (EWGSOP2). The guideline considered low muscle strength to be an indicator of probable sarcopenia [9]. In 2019, the Asia Working Group for Sarcopenia (AWGS) updated its guideline first issued in 2014 and proposed the concept of "possible sarcopenia", which was defined as the existence of low muscle strength with or without reduced physical performance

[10]. Both guidelines recommend using handgrip strength to assess muscle strength, but there are slight differences in threshold values used for diagnosis [9 10].

The uses of these two international guidelines lead to differences in the reported prevalence of possible sarcopenia among different populations. One study determined that the prevalence of probable sarcopenia in a group of subjects in a Colombian community with a mean age 70.4 ± 7.8 years was 46.5% based on threshold values from EWGSOP2 [11]. On the other hand, the values of the prevalence of probable sarcopenia in Swiss women (age 84.1 ± 5.7 years) and men (age 82.6 ± 5.2 years) were determined to be 26.3% and 28.0%, respectively [12]. In a South Korean study, Kim et al used the cut-off values recommended by the AWGS 2019 to screen for the possible sarcopenia and found a prevalence of 20.1% in men (age 76.4 ± 3.9 years) and a prevalence of 29.2% in women (age 75.5 ± 3.9 years) [13].

Despite renewed interest in the condition, few studies have been performed to investigate the prevalence of possible sarcopenia and its relationship to various factors in Chinese populations. Therefore, the aims of this study were (1) to determine the prevalence of possible sarcopenia using the latest guideline (AWGS 2019) in a sample of older adults, aged 60 years and above, in Bengbu, China and (2) to explore the relationship between possible sarcopenia and its associated factors.

Methods

Sample

This was a cross-sectional, community-based study conducted in the city of Bengbu, China, from March, 2022, through June, 2022. Inclusion criteria for study participants were aged at least 60 years, ability to understand relevant issues and ability to provide informed consent. Exclusion criteria were inability to complete the handgrip strength measurement and lack of complete medical or demographic data.

The minimum sample size was calculated to be 792 elderly individuals, assuming a prevalence of possible sarcopenia of 24.6% [13], at a 3% error rate and 95% confidence interval. After considering the design effect as 1.5, the aim was to access a minimum sample size of 1188 individuals. Multi-stage random cluster sampling and random numbers table were conducted. First, all the streets were listed and 7 streets were randomly grouped. Then, 3 communities were randomly grouped into each street. Finally, we contacted the leaders of the selected communities, and randomly recruited residents aged 60 years and above in each community to travel to nearby stalls for assessment. As a result, the final sample included 1082 elderly participants for a 91.08% response rate (Figure 1). Each participant signed an informed consent form. The Ethics Committee of Bengbu Medical College approved the study protocol (Anhui, China; no.2018045).

Patient and public involvement

The older adults were not involved in the design, conduct, reporting or dissemination plans of our research.

Anthropometric measurements

All physical examinations were performed by trained medical students according to standardized procedures. Height and body weight were measured with a steel measuring tape and an electronic scale, respectively. BMI was calculated as the weight in kilograms divided by the square of the height in meters. Waist circumference (WC) was measured from the middle point between the lower border of the rib cage and the iliac crest midaxillary at the end of a normal expiration with a soft measuring tape.

Assessment of possible sarcopenia

AWGS criteria (2019) define possible sarcopenia as the incidence of low muscle strength with or without reduced physical performance, therefore, in this study, low muscle strength was the only criterion used to define possible sarcopenia. Low muscle strength was defined as a handgrip strength of less than 28 kg in men and less than 18 kg in women. Handgrip strength was measured with an electronic hand dynamometer (EH101, https://www.senssun.com). Prior to use, the dynamometer was calibrated according to the manufacturer's instructions. Each participant was asked to hold the dynamometer with the dominant hand with as much force as possible for 3 s. This process was repeated three times with 30 s between each trial, and the handgrip strength was taken as the maximum value from these three trials [10].

Measurement of potential associated factors

Participants were sorted into two groups based on WHO age classification criteria: one group included participants that were aged 60 to 74 years and the other group included participants who were aged at least 75 years. Participants' level of physical activity was determined using self-reported values. According to the latest *World Health Organization 2020 Guidelines on Physical Activity and Sedentary Behavior* [14], physical inactivity was defined as engagement in less than 150 minutes per week of moderate exercise, such as brisk walking, jogging or dancing, and the time of high intensity physical activity was multiplied by 2 to be translated into the time of moderate physical activity. Disease-related factors were assessed with a survey that asked the participants if they had been medically diagnosed with cancer, heart disease, hypertension, hyperlipidemia, diabetes, respiratory diseases, arthritis, or pain in the waist or lower extremities.

Statistical analysis

SPSS 25.0 software (IBM, Armonk, NY, USA) was utilized for data analyses. Continuous variables were expressed as mean ± SD. Categorical variables were expressed as frequencies and percentages. The normality of the variables was verified using Kolmogorov-Smirnov tests. The male and female samples were divided into two groups: no sarcopenia (normal handgrip strength) or possible sarcopenia (weak handgrip strength: < 28 kg in men; < 18 kg in women). Student's t-tests were applied to identify significant differences in normally distributed of continuous variables, while Mann-Whitney U tests were used for comparison of non-normally distributed of continuous variables between groups. The significance of differences in baseline characteristics were examined using chi-squared tests for categorical variables. The associated factors [age group, WC, BMI, physical inactivity, cancer, heart diseases, hypertension, hyperlipidemia, diabetes, respiratory diseases, arthritis, pain in the waist or lower extremities] that were determined to reach the level of significance ($p < 0.05$) were included as independent variables in separate binary logistic regression analysis models for males and females, with possible sarcopenia as the dependent variable.

Results

Data on handgrip strength and anthropometric measures were collected from 1,082 adults aged 60 years and over (n = 466 men, n = 616 women; mean age 76.62 ± 7.11 years). Of the participants, 484 (44.73%) were aged from 60 to 74 years, and 598 (55.27%) were aged at least 75 years.

Possible sarcopenia was determined according to the AWGS 2019 guidelines with gender-specific handgrip strength cut-off values. Of the 466 male participants, possible sarcopenia was identified in 246 (52.79%). Of the 616 female participants, possible sarcopenia was identified in 274 (44.48%). In both men and women, the majority of participants identified as having possible sarcopenia were aged 75 years and over.

Height and weight were significantly lower in the possible sarcopenia group than in the no sarcopenia group (both $p < 0.05$). Among male participants, BMI was significantly lower in the possible sarcopenia group than in the group of no sarcopenia ($p < 0.05$), but there was no statistically significant difference in BMI among female participants ($p > 0.05$). Moreover, the possible sarcopenia group had a great number of participants who were classified as physically inactive (Table 1).

In male participants, older adults with possible sarcopenia were significantly more likely than those without possible sarcopenia to have developed diabetes (22.76% vs 11.82%; $p < 0.05$) and respiratory diseases (9.76% vs 3.64%; $p < 0.05$). Conversely, participants with possible sarcopenia were significantly less likely to have developed hypertension (45.93% vs 57.73%; $p < 0.05$). In female participants, older adults with possible sarcopenia were significantly more likely than those without possible sarcopenia to have developed arthritis (47.81% vs 30.41%; $p < 0.05$), and pain in the waist or lower extremities (61.68% vs 53.80%; $p < 0.05$) (Table 1).

Table 1 Characteristics of participants with or without possible sarcopenia

	Overall sample	Men, n = 466 (43.07%)			Women, n=616 (56.93%)		
	(n = 1082)	Possible sarcopenia (n = 246; 52.79%)	No sarcopenia (n = 220; 47.21%)	*P* value	Possible sarcopenia (n = 274; 44.48%)	No sarcopenia (n = 342; 55.52%)	*P* value
Age (years)	76.62 ± 7.11	79.43 ± 7.33	74.27 ± 4.92	< 0.001	78.90 ± 7.71	74.29 ± 6.31	< 0.001
Age group (n, %)							
60-74 years	484 (44.73)	78 (31.71)	122 (55.45)	< 0.001	82 (29.93)	202 (59.06)	< 0.001
≥ 75 years	598 (55.27)	168 (68.29)	98 (44.55)		192 (70.07)	140 (40.94)	
Height (cm)	158.31 ± 9.28	162.64 ± 6.39	166.11 ± 10.02	< 0.001	151.00 ± 6.92	156.04 ± 6.31	< 0.001
Weight (kg)	63.42 ± 12.27	64.61 ± 10.12	71.80 ± 10.14	< 0.001	56.96 ± 10.55	62.35 ± 12.95	< 0.001
WC (cm)	90.83 ± 9.95	91.26 ± 10.01	91.95 ± 7.92	0.204	89.83 ± 10.76	90.59 ± 10.35	0.553
handgrip strength (kg)	22.91 ± 8.57	21.49 ± 5.21	35.42 ± 5.11	< 0.001	13.85 ± 3.72	23.14 ± 4.13	< 0.001
BMI (kg/m²)	25.40 ± 6.75	24.42 ± 3.49	26.62 ± 11.42	< 0.001	25.00 ± 4.68	25.63 ± 5.72	0.428
Physical inactivity (n, %)	270 (24.95)	71 (28.86)	28 (12.73)	< 0.001	97 (35.40)	74 (21.64)	< 0.001
Cancer (n, %)	18 (1.66)	6 (2.44)	2 (0.91)	0.204	6 (2.19)	4 (1.17)	0.319

Heart diseases (n, %)	345 (31.89)	70 (28.45)	76 (34.55)	0.157	80 (29.20)	119 (34.80)	0.140
Hypertension (n, %)	599 (55.36)	113 (45.93)	127 (57.73)	0.011	170 (62.04)	189 (55.26)	0.090
Hyperlipidemia (n, %)	208 (19.22)	46 (18.70)	44 (20.00)	0.723	48 (17.52)	70 (20.47)	0.355
Diabetes (n, %)	201 (18.58)	56 (22.76)	26 (11.82)	0.002	54 (19.71)	65 (19.01)	0.836
Respiratory diseases (n, %)	93 (8.60)	24 (9.76)	8 (3.64)	0.009	32 (11.68)	29 (8.48)	0.186
Arthritis (n, %)	349 (32.26)	59 (23.98)	55 (25.00)	0.799	131 (47.81)	104 (30.41)	< 0.001
Pain in the waist or lower extremities (n, %)	534 (49.35)	93 (37.80)	89 (40.45)	0.499	169 (61.68)	184 (53.80)	0.049

WC, waist circumference; BMI, body mass index

For male participants, a binary logistic regression analysis showed that the significantly correlating variables age, BMI, physical inactivity, hypertension, diabetes and respiratory diseases explained whether a participant had possible sarcopenia or not to 23.6% (Nagelkerke's $R^2 = 0.236$, Chi-squared (6) = 90.767, $p < 0.0001$), and the percentage accuracy in classification was 65.9%. Higher age (OR = 2.658, 95% CI 1.758-4.019), physical inactivity (OR = 2.779, 95% CI 1.646-4.691) and diabetes (OR = 4.269, 95% CI 2.397-7.602) were risk factors for possible sarcopenia. Conversely, hypertension (OR = 0.586, 95% CI 0.384-0.893) was a protective factor for possible sarcopenia. Moreover, the risk of possible sarcopenia decreased by 12.6% for every 1 kg/m^2 increase of BMI (OR = 0.874, 95% CI 0.817-0.935). Respiratory disease did not have a significant association with possible sarcopenia (Table 2).

For female participants, a binary logistic regression analysis showed that the significantly correlating variables age, physical inactivity, arthritis and pain in lower extremities or waist explained whether a participant had possible sarcopenia or not to 18.5% (Nagelkerke's $R^2 = 0.185$, Chi-squared (4) = 91.593, $p < 0.0001$), and the percentage accuracy in classification was 67.4%. Higher age (OR = 3.821, 95% CI 2.677-5.455), physical inactivity (OR = 2.185, 95% CI 1.488-3.210) and arthritis (OR = 2.076, 95% CI 1.411- 3.056) were risk factors for possible sarcopenia. However, pain in the lower extremities or waist did not have a significant association with possible sarcopenia (Table 3).

Table2 Binary logistic regression analysis of possible sarcopenia category by correlated variables in men

Variables	Wald	Degrees of freedom	*P* value	OR	95% CI	
					Lower	Upper
Age group (≥75 years vs.60-74 years)	21.478	1	< 0.001	2.658	1.758	4.019
Physical inactivity (yes vs. no)	14.640	1	< 0.001	2.779	1.646	4.691
Hypertension (yes vs. no)	6.174	1	0.013	0.586	0.384	0.893
Diabetes (yes vs. no)	24.289	1	< 0.001	4.269	2.397	7.602
Respiratory diseases (yes vs. no)	2.659	1	0.103	2.169	0.855	5.501
BMI	15.378	1	< 0.001	0.874	0.817	0.935
Constant	9.647	1	0.002	14.990		

Age groups, physical inactivity, hypertension, diabetes, respiratory diseases and BMI were simultaneously included in the model.

OR, odds ratio; 95% CI, confidence interval; BMI, body mass index

Table3 Binary logistic regression analysis of possible sarcopenia category by correlated variables in women

Variables	Wald	Degrees of freedom	*P* value	OR	95% CI	
					Lower	Upper
Age group (≥75 years vs.60-74 years)	54.498	1	< 0.001	3.821	2.677	5.455
Physical inactivity (yes vs. no)	15.874	1	< 0.001	2.185	1.488	3.210
Arthritis (yes vs. no)	13.733	1	< 0.001	2.076	1.411	3.056
Pain in the waist or lower extremities (yes vs. no)	0.756	1	0.384	1.186	0.807	1.742
Constant	64.394	1	< 0.001	0.207		

Age groups, physical inactivity, arthritis and pain in the waist or lower extremities were simultaneously included in the model.

OR, odds ratio; 95% CI, confidence interval

Discussion

We investigated the prevalence of possible sarcopenia and its correlation with associated factors. We found that possible sarcopenia has a high prevalence in the community of Bengbu. The prevalence of 48.06% is higher than the prevalence of 38.5% found in adults in another study conducted in China [15]. The reason for this discrepancy may be that the population in our study was older than the population (age 68.13 ± 6.46 years) in the previous study. It should also be noted that the prevalence identified in our study is higher than that found in another study of similarly aged subjects (age 75.9 ± 3.9) from the Asian country of South Korea [13]. The reason for this discrepancy may be that the South Korean study used the calf circumference, SARC-F or SARC-CalF scales to screen participants prior to administering the handgrip strength test, whereas the present study used handgrip strength test directly to identify possible sarcopenia. This difference suggests that many of the older adults in South Korea who were not identified as candidates for the handgrip strength test according to calf circumference, SARC-F or SARC-CalF scale criteria may have had lower handgrip strengths indicative of possible sarcopenia. Therefore, direct measurement of handgrip strength has important clinical value.

Our study found that possible sarcopenia is more common among men than women (52.79% in men and 44.48% in women), as did a study performed by Wearing et al [12] (28% in men and 26.3% in women). Interestingly, Pang et al [16] found that the prevalence of possible sarcopenia in men between the ages of 20 and 60 years (13%) is lower than that in women in the same age group (14.2%), but the relative prevalence in older adults over the age of 60 years is reversed (33.7% in men and 30.9% in women). A possible mechanism of pathogenesis of leading to differences in possible sarcopenia in men and women involves testosterone. Testosterone plays an important role in the development and maintenance of muscle mass and function and can increases muscle mass and muscle strength [17 18]. Testosterone in men declines at a rate of 1% per year after the age of 30, and 40 to 70% of men over the age of 70 have low testosterone levels [19]. This may be one of the important reasons why the prevalence rate of older men is higher than that of women.

We found that high age and physical inactivity are positively associated with the prevalence of possible sarcopenia. This result is consistent with other studies that have identified the main cause of possible sarcopenia as age-related loss of muscle strength. A study of subjects from a Chinese population identified a 50.8% decrease in right handgrip strength in men aged 85 to 90 years compared to men aged 45 to 50 years and a 55.0% decrease in right handgrip strength in women [20]. Several studies have reported that physical inactivity is the primary risk factor for decreased muscle strength [21 22]. Tsekoura et al [23] and Makizako et al [24] confirmed that exercise intervention for older adults slows the decline of muscle strength with age. Nearly a quarter of the participants were physically inactive, which is another potential explanation for the high prevalence of possible sarcopenia observed in this study. The correlations of age and physical inactivity with possible sarcopenia suggests that encouraging more physical activity in older adults is particularly important to prevent or delay the onset and progression of sarcopenia.

The relationships of various factors to possible sarcopenia differed between the sexes. In men, diabetes was found to have a strong correlation with possible sarcopenia. Diabetes was associated with a 4.269-fold increase in the risk of possible sarcopenia in older men, but there was no correlation found in older women. Likewise, a longitudinal study in the United Kingdom showed an increase in probable sarcopenia after eight years in men with diabetes, but not in women [25]. However, Anagnostis et al [26] reported that muscle strength was significantly lower in patients with type 2 diabetes mellitus than in subjects without diabetes, but a significant relationship only existed in women [standardized mean difference (SMD) for women − 0.52, 95% CI − 0.98 to − 0.06, p = 0.02; SMD for men − 0.42, 95% CI − 0.97 to 0.13, p = 0.13]. Thus, it is necessary to further investigate the existence of gender differences in the relationship between diabetes and possible sarcopenia.

We also found that hypertension is a protective factor for possible sarcopenia in men. Several studies showed that patients taking angiotensin converting enzyme inhibitors (ACEI) as therapy for hypertension had higher muscle strength than patients without hypertension and patients with hypertension who were not taking ACEI [27 28]. Similarly, Ata et al pointed that ACEI therapy seems to have favourable effects on both hypertension and sarcopenia [29]. The treatment reduces inflammation and endothelial dysfunction in hypertension [30] and may improve skeletal muscle function by increasing muscle blood flow and glucose delivery [31]. Although more than half of the participants in our study were hypertensive, the medications they were taking were not investigated, so the relationship between hypertensive medications and possible sarcopenia will be further explored in later studies.

We also found that the risk of possible sarcopenia in men decreased by 12.6% for every 1 kg/m^2 increase of BMI. A study based on a Korean population showed that BMI was positively correlated with handgrip strength in both men and women, and the correlation was higher in men (β = 0.976, r = 0.378) than in women (β = 0.190, r = 0.134) [32]. Older adults with low BMI values may be underweight and at risk of malnutrition. For example, Granic et al [33] found that a low protein intake (<1g/kg) was associated with lower handgrip strength. A systematic review and meta-analysis showed that multi-nutrients significantly improved handgrip strength (n = 6 studies; 780 participants; SMD = 0.41; 95%CI: 0.06 to 0.76; I^2 = 79%), and nutritional supplementations with protein or amino acids was also associated with improved handgrip strength (n = 7studies; 535 participants; SMD = 0.24; 95%CI: 0.07 to 0.41; I^2 = 16%) [34]. Therefore, early nutritional intervention for older patients with possible sarcopenia is an important strategy in decreasing the risk of progression to sarcopenia.

In our study, women with arthritis were found to have a higher risk of possible sarcopenia. There are more than 100 types of arthritis. Rheumatoid arthritis (RA) is the most common form, but other common types of arthritis include osteoarthritis and inflammatory arthritis [35]. Several studies have shown that women are more likely to be diagnosed with RA than men [36-38], and adults with RA tend to have lower muscle masses or strengths compared to adults without RA [39-41]. Notably, RA can cause joint pain and deformity, therefore, it is unclear to what extent decreases in handgrip strength in patients with RA reflect true low muscle strength and how much of the limited handgrip strength may be secondary to pain or deformity [42]. Thence, other measurements should be considered to assess the possible sarcopenia in arthritis adults.

The major strength of our study is that it assessed possible sarcopenia using the latest guideline (AWGS 2019) and analyzed two subgroups based on gender. However, several limitations should be mentioned. First, this study focused solely on a population of older adults in Bengbu, so findings may not be generalizable to other populations. Second, we did not investigate nutritional factors that may be related to possible sarcopenia; a nutrition survey will be added in future studies.

Conclusions

The prevalence of possible sarcopenia in older adults in Bengbu is high, and it is more common among men than women. Men with high age, physical inactivity, diabetes and no hypertension had a higher prevalence of possible sarcopenia. And BMI was also found to be an independent risk factor for possible sarcopenia in men. Women with high age, physical inactivity and arthritis had a higher prevalence of possible sarcopenia. Community health care institutions should pay attention to the screening of possible sarcopenia, especially among older men. Targeted health education should also be carried out to encourage older adults to actively participate in physical exercise.

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Conflict of interest The authors have no conflicts of interest.

Ethics approval Ethical approval was obtained by the ethics committees of Bengbu Medical College (Anhui, China; no.2018045).

Statement of human participants and/or animals All the procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments.

Informed consent All individual participants in the research gave their informed consent.

Data availability statement The data are held at Physical fitness center of Bengbu Medical College.

Author contributions Jiaqin Yao: conceptualization, methodology, data collection, writing, investigation, statistical analysis. Yaoting Wang: data collection, methodology, writing, investigation. Lin Yang: data collection, writing. Mengting Ren: data collection, writing. Lingyan Li: writing. Hongyu Wang: conceptualization, methodology, statistical analysis.

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Figure Figure 1 participation of older adults

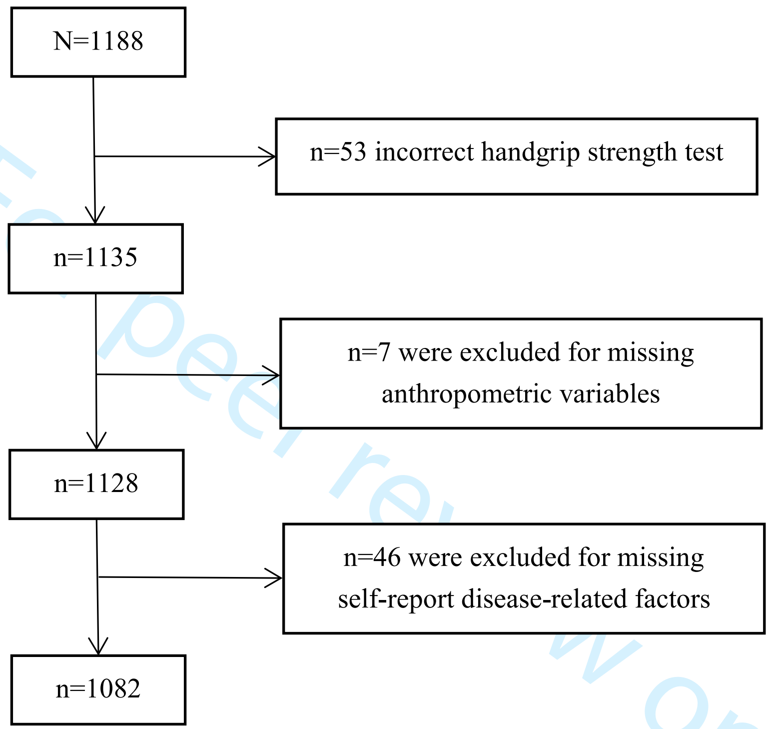

Figure 1 participation of older adults

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study’s design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	#3	State specific objectives, including any prespecified hypotheses	3
Methods			

Study design	#4	Present key elements of study design early in the paper	3
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3-4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	3-4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4-5
Bias	#9	Describe any efforts to address potential sources of bias	4(All physical examinations were performed by trained medical students according to standardized procedures.)
Study size	#10	Explain how the study size was arrived at	3-4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	4-5
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	5
Statistical methods	#12c	Explain how missing data were addressed	3 and Figure 1
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	3-4
Statistical	#12e	Describe any sensitivity analyses	4-5

methods

Results

Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	3-4
Participants	#13b	Give reasons for non-participation at each stage	3-4 (Figure 1)
Participants	#13c	Consider use of a flow diagram	Figure 1
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5-8
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	3(Figure 1)
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	5-8
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NO (The study did not adjust for confounding factors.)
Main results	#16b	Report category boundaries when continuous variables were categorized	3-4
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NO
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	6-8(The study was divided into two subgroups: men and

			women)

Discussion

Key results	#18	Summarise key results with reference to study objectives	8-11
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	11
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	8-11
Generalisability	#21	Discuss the generalisability (external validity) of the study results	11

Other Information

Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

None

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Prevalence of possible sarcopenia in community-dwelling older Chinese adults: a cross-sectional study

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Prevalence of possible sarcopenia in community-dwelling older Chinese adults: a cross-sectional study

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Abstract

Objectives To determine the prevalence of possible sarcopenia and its association with other conditions in older adults in Bengbu, China.

Design, setting and participants A cross-sectional study of 1082 community-dwelling Chinese people aged at least 60 years from March to June, 2022.

Methods Handgrip strength and information regarding associated conditions were collected. Possible sarcopenia was estimated based on handgrip strength with cut-off values (< 28 kg in men; < 18 kg in women) recommended by the Asia Working Group for Sarcopenia in 2019 (AWGS 2019). Mann-Whitney U tests, Chi-square tests and binary logistic regression analyses were used to explore relationships between possible sarcopenia and associated conditions.

Results Possible sarcopenia was more prevalent in men (52.79%, n = 246, age 79.43 ± 7.33 years among men with possible sarcopenia) than in women (44.48%, n = 274, age 78.90 ± 7.71 years among women with possible sarcopenia). In men, possible sarcopenia positively correlated with high age [odds ratio (OR) = 2.658, 95% confidence interval (CI) 1.758-4.019], physical inactivity (OR = 2.779, 95% CI 1.646-4.691) and diabetes (OR = 4.269, 95% CI 2.397-7.602), and negatively with hypertension (OR = 0.586, 95% CI 0.384-0.893). The risk of possible sarcopenia in men decreased by 12.6% for every 1 kg/m^2 increase of body mass index (BMI) (OR = 0.874, 95% CI 0.817-0.935). In women, possible sarcopenia positively correlated with high age (OR = 3.821, 95% CI 2.677-5.455), physical inactivity (OR = 2.185, 95% CI 1.488-3.210) and arthritis (OR = 2.076, 95% CI 1.411-3.056).

Conclusion Possible sarcopenia is prevalent in older adults and the factors affecting possible sarcopenia are different in men and women. Health education about these target factors can be considered as a potential measure to prevent possible sarcopenia.

Strengths and limitations of this study

⇒ This study used the concept of low handgrip strength (< 28 kg in men; < 18 kg in women) in the latest guideline (AWGS 2019) to assess possible sarcopenia.

⇒ The grouping of subjects by sex permitted additional insight into risk factors.

⇒ Because it was a cross-sectional study, cause-effect relationships could not be determined.

Introduction

As an independent disease in the 10th edition of International Classification of Diseases, sarcopenia has become an important public health issue [1]. Sarcopenia is a geriatric syndrome characterized by loss of muscle mass and muscle strength and decreased physical function [2]. Substantial evidence suggests that sarcopenia has an important impact on the health of older adults, and it often is associated with adverse outcomes such as illness, falls, reduced quality of life and even death [3]. Sarcopenia is not only associated with aging, but it can also result from a combination of chronic diseases including respiratory disease [4], diabetes [5] and cancer [6]. It is associated with environmental factors, and the risk of developing sarcopenia can be lowered by changes to physical activity and diet [7 8].

In order to help predict the occurrence of sarcopenia in at-risk populations, the concept of "probable sarcopenia" was introduced in the guideline of the European Working Group on Sarcopenia in Older People in 2018 (EWGSOP2). The guideline considered low muscle strength to be an indicator of probable sarcopenia [9]. In 2019, the Asia Working Group for Sarcopenia (AWGS) updated its guideline first issued in 2014 and proposed the concept of "possible sarcopenia", which was defined as the existence of low muscle strength with or without reduced physical performance

[10]. Both guidelines recommend using handgrip strength to assess muscle strength, but there are slight differences in threshold values used for diagnosis [9 10].

The uses of these two international guidelines lead to differences in the reported prevalence of possible sarcopenia among different populations. One study determined that the prevalence of probable sarcopenia in a group of subjects in a Colombian community with a mean age 70.4 ± 7.8 years was 46.5% based on threshold values from EWGSOP2 [11]. On the other hand, the values of the prevalence of probable sarcopenia in Swiss women (age 84.1 ± 5.7 years) and men (age 82.6 ± 5.2 years) were determined to be 26.3% and 28.0%, respectively [12]. In a South Korean study, Kim et al used the cut-off values recommended by the AWGS 2019 to screen for the possible sarcopenia and found a prevalence of 20.1% in men (age 76.4 ± 3.9 years) and a prevalence of 29.2% in women (age 75.5 ± 3.9 years) [13].

Despite renewed interest in the condition, few studies have been performed to investigate the prevalence of possible sarcopenia and its relationship to various factors in Chinese populations. Therefore, the aims of this study were (1) to determine the prevalence of possible sarcopenia using the latest guideline (AWGS 2019) in a sample of older adults, aged 60 years and above, in Bengbu, China and (2) to explore the relationship between possible sarcopenia and its associated factors.

Methods

Sample

This was a cross-sectional, community-based study conducted in the city of Bengbu, China, from March, 2022, through June, 2022. Inclusion criteria for study participants were aged at least 60 years, ability to understand relevant issues and ability to provide informed consent. Exclusion criteria were inability to complete the handgrip strength measurement and lack of complete medical or demographic data.

To ensure that the sample findings were valid for estimating the prevalence of possible sarcopenia in the general population, we calculated a minimum sample size of 792, assuming a prevalence of possible sarcopenia of 24.6% [13], at a 3% error rate and 95% confidence interval. After considering the design effect as 1.5, the aim was to access a minimum sample size of 1188 individuals. Multi-stage random cluster sampling and random numbers table were conducted. First, all the streets were listed and 7 streets were randomly grouped. Then, 3 communities were randomly grouped into each street. Finally, we contacted the leaders of the selected communities, and randomly recruited residents aged 60 years and above in each community to travel to nearby stalls for assessment. As a result, the final sample included 1082 elderly participants for a 91.08% response rate (Figure 1). Each participant signed an informed consent form. The Ethics Committee of Bengbu Medical College approved the study protocol (Anhui, China; no.2018045).

Patient and public involvement

The older adults were not involved in the design, conduct, reporting or dissemination plans of our research.

Anthropometric measurements

All physical examinations were performed by trained medical students according to standardized procedures. Height and body weight were measured with a steel measuring tape and an electronic scale, respectively. BMI was calculated as the weight in kilograms divided by the square of the height in meters. Waist circumference (WC) was measured from the middle point between the lower border of the rib cage and the iliac crest midaxillary at the end of a normal expiration with a soft measuring tape.

Assessment of possible sarcopenia

AWGS criteria (2019) define possible sarcopenia as the incidence of low muscle strength with or without reduced physical performance, therefore, in this study, low muscle strength was the only criterion used to define possible sarcopenia. Low muscle strength was defined as a handgrip strength of less than 28 kg in men and less than 18 kg in women. Handgrip strength was measured with an electronic hand dynamometer (EH101, https://www.senssun.com). Prior to use, the dynamometer was calibrated according to the manufacturer's instructions. Each participant was asked to hold the dynamometer with the dominant hand with as much force as possible for 3 s. This process was repeated three times with 30 s between each trial, and the handgrip strength was taken as the maximum value from these three trials [10].

Measurement of potential associated factors

Participants were sorted into two groups based on WHO age classification criteria: one group included participants that were aged 60 to 74 years and the other group included participants who were aged at least 75 years. Participants' level of physical activity was determined using self-reported values. According to the latest *World Health Organization 2020 Guidelines on Physical*

Activity and Sedentary Behavior [14], physical inactivity was defined as engagement in less than 150 minutes per week of moderate exercise, such as brisk walking, jogging or dancing, and the time of high intensity physical activity was multiplied by 2 to be translated into the time of moderate physical activity. Disease-related factors were assessed with a survey that asked the participants if they had been medically diagnosed with cancer, heart disease, hypertension, hyperlipidemia, diabetes, respiratory diseases, arthritis, or pain in the waist or lower extremities.

Statistical analysis

SPSS 25.0 software (IBM, Armonk, NY, USA) was utilized for data analyses. Continuous variables were expressed as mean ± SD. Categorical variables were expressed as frequencies and percentages. The normality of the variables was verified using Kolmogorov-Smirnov tests. The male and female samples were divided into two groups: no sarcopenia (normal handgrip strength) or possible sarcopenia (weak handgrip strength: < 28 kg in men; < 18 kg in women). Student's t-tests were applied to identify significant differences in normally distributed of continuous variables, while Mann-Whitney U tests were used for comparison of non-normally distributed of continuous variables between groups. The significance of differences in baseline characteristics were examined using chi-squared tests for categorical variables. The associated factors [age group, WC, BMI, physical inactivity, cancer, heart diseases, hypertension, hyperlipidemia, diabetes, respiratory diseases, arthritis, pain in the waist or lower extremities] that were determined to reach the level of significance ($p < 0.05$) were included as independent variables in separate binary logistic regression analysis models for males and females, with possible sarcopenia as the dependent variable.

Results

Data on handgrip strength and anthropometric measures were collected from 1,082 adults aged 60 years and over (n = 466 men, n = 616 women; mean age 76.62 ± 7.11 years). Of the participants, 484 (44.73%) were aged from 60 to 74 years, and 598 (55.27%) were aged at least 75 years.

Possible sarcopenia was determined according to the AWGS 2019 guidelines with gender-specific handgrip strength cut-off values. Of the 466 male participants, possible sarcopenia was identified in 246 (52.79%). Of the 616 female participants, possible sarcopenia was identified in 274 (44.48%). In both men and women, the majority of participants identified as having possible sarcopenia were aged 75 years and over.

Height and weight were significantly lower in the possible sarcopenia group than in the no sarcopenia group (both $p < 0.05$). Among male participants, BMI was significantly lower in the possible sarcopenia group than in the group of no sarcopenia ($p < 0.05$), but there was no statistically significant difference in BMI among female participants ($p > 0.05$). Moreover, the possible sarcopenia group had a great number of participants who were classified as physically inactive (Table 1).

In male participants, older adults with possible sarcopenia were significantly more likely than those without possible sarcopenia to have developed diabetes (22.76% vs 11.82%; $p < 0.05$) and respiratory diseases (9.76% vs 3.64%; $p < 0.05$). Conversely, participants with possible sarcopenia were significantly less likely to have developed hypertension (45.93% vs 57.73%; $p < 0.05$). In female participants, older adults with possible sarcopenia were significantly more likely than those without possible sarcopenia to have developed arthritis (47.81% vs 30.41%; $p < 0.05$), and pain in the waist or lower extremities (61.68% vs 53.80%; $p < 0.05$) (Table 1).

Table 1 Characteristics of participants with or without possible sarcopenia

	Overall sample	Men, n = 466 (43.07%)			Women, n=616 (56.93%)		
	(n = 1082)	Possible sarcopenia (n = 246; 52.79%)	No sarcopenia (n = 220; 47.21%)	*P* value	Possible sarcopenia (n = 274; 44.48%)	No sarcopenia (n = 342; 55.52%)	*P* value
Age (years)	76.62 ± 7.11	79.43 ± 7.33	74.27 ± 4.92	< 0.001	78.90 ± 7.71	74.29 ± 6.31	< 0.001
Age group (n, %)							
60-74 years	484 (44.73)	78 (31.71)	122 (55.45)	< 0.001	82 (29.93)	202 (59.06)	< 0.001
≥ 75 years	598 (55.27)	168 (68.29)	98 (44.55)		192 (70.07)	140 (40.94)	
Height (cm)	158.31 ± 9.28	162.64 ± 6.39	166.11 ± 10.02	< 0.001	151.00 ± 6.92	156.04 ± 6.31	< 0.001
Weight (kg)	63.42 ± 12.27	64.61 ± 10.12	71.80 ± 10.14	< 0.001	56.96 ± 10.55	62.35 ± 12.95	< 0.001
WC (cm)	90.83 ± 9.95	91.26 ± 10.01	91.95 ± 7.92	0.204	89.83 ± 10.76	90.59 ± 10.35	0.553
handgrip strength (kg)	22.91 ± 8.57	21.49 ± 5.21	35.42 ± 5.11	< 0.001	13.85 ± 3.72	23.14 ± 4.13	< 0.001
BMI (kg/m^2)	25.40 ± 6.75	24.42 ± 3.49	26.62 ± 11.42	< 0.001	25.00 ± 4.68	25.63 ± 5.72	0.428
Physical inactivity (n, %)	270 (24.95)	71 (28.86)	28 (12.73)	< 0.001	97 (35.40)	74 (21.64)	< 0.001

Cancer (n, %)	18 (1.66)	6 (2.44)	2 (0.91)	0.204	6 (2.19)	4 (1.17)	0.319
Heart diseases (n, %)	345 (31.89)	70 (28.45)	76 (34.55)	0.157	80 (29.20)	119 (34.80)	0.140
Hypertension (n, %)	599 (55.36)	113 (45.93)	127 (57.73)	0.011	170 (62.04)	189 (55.26)	0.090
Hyperlipidemia (n, %)	208 (19.22)	46 (18.70)	44 (20.00)	0.723	48 (17.52)	70 (20.47)	0.355
Diabetes (n, %)	201 (18.58)	56 (22.76)	26 (11.82)	0.002	54 (19.71)	65 (19.01)	0.836
Respiratory diseases (n, %)	93 (8.60)	24 (9.76)	8 (3.64)	0.009	32 (11.68)	29 (8.48)	0.186
Arthritis (n, %)	349 (32.26)	59 (23.98)	55 (25.00)	0.799	131 (47.81)	104 (30.41)	< 0.001
Pain in the waist or lower extremities (n, %)	534 (49.35)	93 (37.80)	89 (40.45)	0.499	169 (61.68)	184 (53.80)	0.049

WC, waist circumference; BMI, body mass index

For male participants, a binary logistic regression analysis showed that the correlating variables age, BMI, physical inactivity, hypertension, diabetes and respiratory diseases explained whether a participant had possible sarcopenia or not to 23.6% (Nagelkerke's $R^2 = 0.236$, Chi-squared (6) = 90.767, $p < 0.0001$), and the percentage accuracy in classification was 65.9%. Higher age (OR = 2.658, 95% CI 1.758-4.019), physical inactivity (OR = 2.779, 95% CI 1.646-4.691) and diabetes (OR = 4.269, 95% CI 2.397-7.602) were risk factors for possible sarcopenia. Conversely, hypertension (OR = 0.586, 95% CI 0.384-0.893) was a protective factor for possible sarcopenia. Moreover, the risk of possible sarcopenia decreased by 12.6% for every 1 kg/m^2 increase of BMI (OR = 0.874, 95% CI 0.817-0.935). Respiratory disease did not have a significant association with possible sarcopenia (Table 2).

For female participants, a binary logistic regression analysis showed that the correlating variables age, physical inactivity, arthritis and pain in lower extremities or waist explained whether a participant had possible sarcopenia or not to 18.5% (Nagelkerke's $R^2 = 0.185$, Chi-squared (4) = 91.593, $p < 0.0001$), and the percentage accuracy in classification was 67.4%. Higher age (OR = 3.821, 95% CI 2.677-5.455), physical inactivity (OR = 2.185, 95% CI 1.488-3.210) and arthritis (OR = 2.076, 95% CI 1.411- 3.056) were risk factors for possible sarcopenia. However, pain in the lower extremities or waist did not have a significant association with possible sarcopenia (Table 3).

Table2 Binary logistic regression analysis of possible sarcopenia category by correlated variables in men

Variables	Wald	Degrees of freedom	*P* value	OR	95% CI	
					Lower	Upper
Age group (≥75 years vs.60-74 years)	21.478	1	< 0.001	2.658	1.758	4.019
Physical inactivity (yes vs. no)	14.640	1	< 0.001	2.779	1.646	4.691
Hypertension (yes vs. no)	6.174	1	0.013	0.586	0.384	0.893
Diabetes (yes vs. no)	24.289	1	< 0.001	4.269	2.397	7.602
Respiratory diseases (yes vs. no)	2.659	1	0.103	2.169	0.855	5.501
BMI	15.378	1	< 0.001	0.874	0.817	0.935
Constant	9.647	1	0.002	14.990		

Age groups, physical inactivity, hypertension, diabetes, respiratory diseases and BMI were simultaneously included in the model.

OR, odds ratio; 95% CI, confidence interval; BMI, body mass index

Table3 Binary logistic regression analysis of possible sarcopenia category by correlated variables in women

Variables	Wald	Degrees of freedom	*P* value	OR	95% CI	
					Lower	Upper
Age group (≥75 years vs.60-74 years)	54.498	1	< 0.001	3.821	2.677	5.455
Physical inactivity (yes vs. no)	15.874	1	< 0.001	2.185	1.488	3.210
Arthritis (yes vs. no)	13.733	1	< 0.001	2.076	1.411	3.056
Pain in the waist or lower extremities (yes vs. no)	0.756	1	0.384	1.186	0.807	1.742
Constant	64.394	1	< 0.001	0.207		

Age groups, physical inactivity, arthritis and pain in the waist or lower extremities were simultaneously included in the model.

OR, odds ratio; 95% CI, confidence interval

Discussion

We investigated the prevalence of possible sarcopenia and its correlation with associated factors. We found that possible sarcopenia has a high prevalence in the community of Bengbu. The prevalence of 48.06% is higher than the prevalence of 38.5% found in adults in another study conducted in China [15]. The reason for this discrepancy may be that the population in our study was older than the population (age 68.13 ± 6.46 years) in the previous study. It should also be noted that the prevalence identified in our study is higher than that found in another study of similarly aged subjects (age 75.9 ± 3.9) from the Asian country of South Korea [13]. The reason for this discrepancy may be that the South Korean study used the calf circumference, SARC-F or SARC-CalF scales to screen participants prior to administering the handgrip strength test, whereas the present study used handgrip strength test directly to identify possible sarcopenia. This difference suggests that many of the older adults in South Korea who were not identified as candidates for the handgrip strength test according to calf circumference, SARC-F or SARC-CalF scale criteria may have had lower handgrip strengths indicative of possible sarcopenia. Therefore, direct measurement of handgrip strength has important clinical value.

Our study found that possible sarcopenia is more common among men than women (52.79% in men and 44.48% in women), as did a study performed by Wearing et al [12] (28% in men and 26.3% in women). Interestingly, Pang et al [16] found that the prevalence of possible sarcopenia in men between the ages of 20 and 60 years (13%) is lower than that in women in the same age group (14.2%), but the relative prevalence in older adults over the age of 60 years is reversed (33.7% in men and 30.9% in women). A possible mechanism of pathogenesis of leading to differences in possible sarcopenia in men and women involves testosterone. Testosterone plays an important role in the development and maintenance of muscle mass and function and can increases muscle mass and muscle strength [17 18]. Testosterone in men declines at a rate of 1% per year after the age of 30, and 40 to 70% of men over the age of 70 have low testosterone levels [19]. This may be one of the important reasons why the prevalence rate of older men is higher than that of women.

We found that high age and physical inactivity are positively associated with the prevalence of possible sarcopenia. This result is consistent with other studies that have identified the main cause of possible sarcopenia as age-related loss of muscle strength. A study of subjects from a Chinese population identified a 50.8% decrease in right handgrip strength in men aged 85 to 90 years compared to men aged 45 to 50 years and a 55.0% decrease in right handgrip strength in women [20]. Several studies have reported that physical inactivity is the primary risk factor for decreased muscle strength [21 22]. Tsekoura et al [23] and Makizako et al [24] confirmed that exercise intervention for older adults slows the decline of muscle strength with age. Nearly a quarter of the participants were physically inactive, which is another potential explanation for the high prevalence of possible sarcopenia observed in this study. The correlations of age and physical inactivity with possible sarcopenia suggests that encouraging more physical activity in older adults is particularly important to prevent or delay the onset and progression of sarcopenia.

The relationships of various factors to possible sarcopenia differed between the sexes. In men, diabetes was found to have a strong correlation with possible sarcopenia. Diabetes was associated with a 4.269-fold increase in the risk of possible sarcopenia in older men, but there was no correlation found in older women. Likewise, a longitudinal study in the United Kingdom showed an increase in probable sarcopenia after eight years in men with diabetes, but not in women [25]. However, Anagnostis et al [26] reported that muscle strength was significantly lower in patients with type 2 diabetes mellitus than in subjects without diabetes, but a significant relationship only existed in women [standardized mean difference (SMD) for women − 0.52, 95% CI − 0.98 to − 0.06, p = 0.02; SMD for men − 0.42, 95% CI − 0.97 to 0.13, p = 0.13]. Thus, it is necessary to further investigate the existence of gender differences in the relationship between diabetes and possible sarcopenia.

We also found that hypertension is a protective factor for possible sarcopenia in men. Several studies showed that patients taking angiotensin converting enzyme inhibitors (ACEI) as therapy for hypertension had higher muscle strength than patients without hypertension and patients with hypertension who were not taking ACEI [27 28]. Similarly, Ata et al pointed that ACEI therapy seems to have favourable effects on both hypertension and sarcopenia [29]. The treatment reduces inflammation and endothelial dysfunction in hypertension [30] and may improve skeletal muscle function by increasing muscle blood flow and glucose delivery [31]. Although more than half of the participants in our study were hypertensive, the medications they were taking were not investigated, so the relationship between hypertensive medications and possible sarcopenia will be further explored in later studies.

We also found that the risk of possible sarcopenia in men decreased by 12.6% for every 1 kg/m^2 increase of BMI. A study based on a Korean population showed that BMI was positively correlated with handgrip strength in both men and women, and the correlation was higher in men (β = 0.976, r = 0.378) than in women (β = 0.190, r = 0.134) [32]. Older adults with low BMI values may be underweight and at risk of malnutrition. For example, Granic et al [33] found that a low protein intake (<1g/kg) was associated with lower handgrip strength. A systematic review and meta-analysis showed that multi-nutrients significantly improved handgrip strength (n = 6 studies; 780 participants; SMD = 0.41; 95%CI: 0.06 to 0.76; I^2 = 79%), and nutritional supplementations with protein or amino acids was also associated with improved handgrip strength (n = 7studies; 535 participants; SMD = 0.24; 95%CI: 0.07 to 0.41; I^2 = 16%) [34]. Therefore, early nutritional intervention for older patients with possible sarcopenia is an important strategy in decreasing the risk of progression to sarcopenia.

In our study, women with arthritis were found to have a higher risk of possible sarcopenia. There are more than 100 types of arthritis. Rheumatoid arthritis (RA) is the most common form, but other common types of arthritis include osteoarthritis and inflammatory arthritis [35]. Several studies have shown that women are more likely to be diagnosed with RA than men [36-38], and adults with RA tend to have lower muscle masses or strengths compared to adults without RA [39-41]. Notably, RA can cause joint pain and deformity, therefore, it is unclear to what extent decreases in handgrip strength in patients with RA reflect true low muscle strength and how much of the limited handgrip strength may be secondary to pain or deformity [42]. Thence, other measurements should be considered to assess the possible sarcopenia in arthritis adults.

The major strength of our study is that it assessed possible sarcopenia using the latest guideline (AWGS 2019) and analyzed two subgroups based on gender. However, several limitations should be mentioned. First, this study focused solely on a population of older adults in Bengbu, so findings may not be generalizable to other populations. Second, we did not investigate nutritional factors that may be related to possible sarcopenia; a nutrition survey will be added in future studies.

Conclusions

The prevalence of possible sarcopenia in older adults in Bengbu is high, and it is more common among men than women. Men with high age, physical inactivity, diabetes and no hypertension had a higher prevalence of possible sarcopenia. And BMI was also found to be an independent risk factor for possible sarcopenia in men. Women with high age, physical inactivity and arthritis had a higher prevalence of possible sarcopenia. Community health care institutions should pay attention to the screening of possible sarcopenia, especially among older men. Targeted health education should also be carried out to encourage older adults to actively participate in physical exercise.

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Conflict of interest The authors have no conflicts of interest.

Ethics approval Ethical approval was obtained by the ethics committees of Bengbu Medical College (Anhui, China; no.2018045).

Statement of human participants and/or animals All the procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Declaration of Helsinki and its later amendments.

Informed consent All individual participants in the research gave their informed consent.

Data availability statement The data are held at Physical fitness center of Bengbu Medical College.

Author contributions Jiaqin Yao: conceptualization, methodology, data collection, writing, investigation, statistical analysis. Yaoting Wang: data collection, methodology, writing, investigation. Lin Yang: data collection, writing. Mengting Ren: data collection, writing. Lingyan Li: writing. Hongyu Wang: conceptualization, methodology, statistical analysis.

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Figure Figure 1 participation of older adults

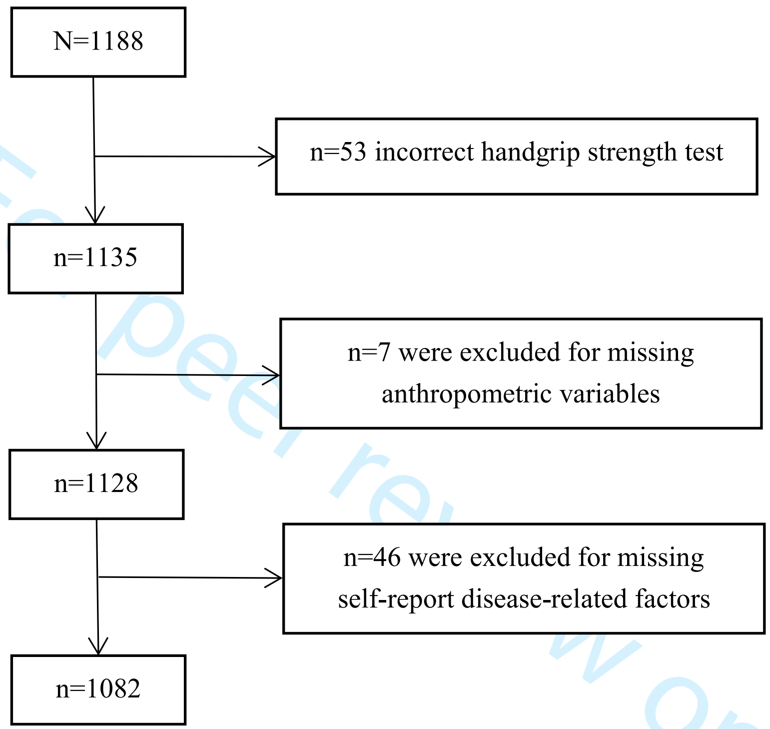

Figure 1 participation of older adults

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cross sectionalreporting guidelines, and cite them as:

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study’s design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	1-2
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	2-3
Objectives	#3	State specific objectives, including any prespecified hypotheses	3
Methods			

Study design	#4	Present key elements of study design early in the paper	3
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3-4
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	3-4
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4-5
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	4-5
Bias	#9	Describe any efforts to address potential sources of bias	4(All physical examinations were performed by trained medical students according to standardized procedures.)
Study size	#10	Explain how the study size was arrived at	3-4
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	4-5
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	5
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	5
Statistical methods	#12c	Explain how missing data were addressed	3-4 and Figure 1
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	3-4
Statistical	#12e	Describe any sensitivity analyses	5

methods

Results

Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	3-4
Participants	#13b	Give reasons for non-participation at each stage	3-4 (Figure 1)
Participants	#13c	Consider use of a flow diagram	Figure 1
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	5-8
Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	3(Figure 1)
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	5-8
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NO (The study did not adjust for confounding factors.)
Main results	#16b	Report category boundaries when continuous variables were categorized	3-4
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NO
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	6-8(The study was divided into two subgroups: men and

			women)
Discussion			
Key results	#18	Summarise key results with reference to study objectives	8-11
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	11
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	8-11
Generalisability	#21	Discuss the generalisability (external validity) of the study results	11
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	12

None