

Association between Sarcopenia and Chronic Lung Diseases among Older Chinese: Findings from the China Health and Retirement Longitudinal Study

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Abstract. To analyze the association between sarcopenia and chronic lung diseases among older Chinese, we obtained the data from China Health and Retirement Longitudinal Study (CHARLS) in 2015. Sarcopenia were classified according to the Asian Working Group for Sarcopenia (AWGS) 2019 criteria. Chronic lung diseases were previously diagnosed by physicians. The logistic regression model was used to analyze the association between sarcopenia and chronic lung diseases. A total of 5093 participants aged over 60 were included. The prevalence of chronic lung diseases in total populations, non-sarcopenia, possible sarcopenia, sarcopenia individuals were 13.9% (710/5093), 12.3% (353/2875), 14.8% (253/1705), and 20.3% (104/513), respectively. Both possible sarcopenia (OR: 1.30; 95% CI: 1.07-1.57, P = 0.008) and sarcopenia (OR: 1.36; 95% CI: 1.00-1.86, P = 0.051) were significantly associated with the prevalence of chronic lung diseases. In conclusion, possible sarcopenia and sarcopenia are independent risk factors for the prevalence of chronic lung diseases among older Chinese.

Keywords: CHARLS, sarcopenia, possible sarcopenia, chronic lung diseases, older Chinese.

1. Introduction (Heading 1)

Sarcopenia is a geriatric syndrome associated with diminishing muscle mass, strength, and function with age, which increases the risk of falls and fractures, accompanied by metabolic disorders and a decline in daily activities[1]. This condition was first named by Rosenberg in 1989. In 2010 and 2011, the European Working Group on Sarcopenia in Older People (EWGSOP) and the International Working Group for Sarcopenia (IWGS) released their consensus on Sarcopenia diagnosis and treatment. The Asian Working Group for Sarcopenia (AWGS) further updated the consensus in 2019. The case finding and diagnostic protocols of sarcopenia have been much discussed in recent years[2]. Early sarcopenia was mainly identified by dual X-ray absorptiometry (DXA). Nowadays, the algorithm for identifying and diagnosing older adults with or at-risk for sarcopenia requires the determination of muscle mass, strength, and mobility[1].

Chronic lung diseases include chronic airway and interstitial diseases, and chronic pneumonia, often linked to long-term smoking[3, 4]. Studies [5-8] have shown that age is an independent risk factor for chronic lung diseases, such as chronic obstructive pulmonary disease (COPD). The prevalence of COPD among individuals older than 65 is 14% (Ref). Chronic lung diseases increase physical energy expenditure and reduced activity tolerance, which may be aggravated by sarcopenia and leads to further deterioration of lung function and daily routines. Therefore, exploring the possible association between sarcopenia and chronic lung diseases potentially promotes early intervention in disease occurrence and improves the quality of life among older Chinese.

Numerous studies[8-14] have assessed the relationship between sarcopenia and chronic lung disease. For instance, Limpawattana et al.[10] indicated that COPD severity was associated with sarcopenia in Thailand., Costa et al.[12] identified that sarcopenia was associated with adverse changes in body composition and poor prognosis of COPD patients in Portugal, Martínez-Luna et al.[14] confirmed that sarcopenia, muscle depletion, and low muscle strength were correlated with deteriorating lung function in Mexico, while Byun et al.[11] stated that sarcopenia was associated with systemic inflammation in COPD patients in South Korea. Nonetheless, most studies described major limitations in their research, including small sample sizes, insufficient representation, and

different diagnostic criteria, resulting in discrepancies concerning the association between sarcopenia and chronic lung diseases.

Few studies have evaluated whether sarcopenia increases the risk of chronic lung diseases. The AWGS 2019 considered low muscle mass or function as a feature of possible sarcopenia, but no study had evaluated the correlation between this condition and chronic lung diseases. In addition, the relevance between individuals with low muscle mass without other sarcopenia characteristics and chronic lung diseases requires further investigation. Using data from the China Health and Retirement Longitudinal Study (CHARLS), this study analyzes the association between sarcopenia and chronic lung diseases among older Chinese.

2. Methods

2.1 Study population

The CHARLS collected micro-data of families and individuals aged 45 and older in China to promote research on issues related to population aging in China. This study utilized the multistage probability proportional scale sampling method to determine the national baseline survey in 2011 and later updated in 2013, 2015, and 2018. The survey stratified the random sampling to four levels (county, community, family, and respondent level) to include eligible individuals. The primary sampling units (PSUs) were different at all levels: (1) County-level: the sampling was stratified according to regions, towns or villages, and gross domestic product (GDP), and (2) Community level: rural and urban areas are assigned as administrative villages and communities acted as PSUs, and (3) House-hold-level: dwellings were chosen on the basis of maps and lists of each PSU, and (4) Respondent-level, one person aged 45 years or older in a selected household was randomly selected to be the main respondent[15]. In CHARLS 2011, a total of 17,708 participants in 10,257 households were recruited from 150 counties or districts and 450 villages within 28 provinces in China. All participants were followed up every 2 years after the baseline survey. The computer-aided interview was utilized in collecting demographic data from respondents and their families, including health status, work and retirement, pension, and housing information. Detailed information about CHARLS (including the purpose, sampling, and questionnaire) can be found in the previously published literature[13]. The Biomedical Ethics Review Committee of Peking University approved CHARLS (approval number: IRB00001052-11015), and all participants were required to provide written informed consent.

This study utilized the data from CHARLS 2015, and the inclusion criteria were: (1) individuals aged 60 years and older, and (2) data available on sarcopenia. The exclusion criteria were: (1) missing data on chronic lung diseases ($n = 13004$), (2) missing data on sarcopenia status ($n = 1720$), (3) participants aged < 60 years old ($n = 1221$), and (4) missing data on body mass index (BMI) ($n = 57$). The detailed flow chart of the sample screening process is illustrated in Figure 1.

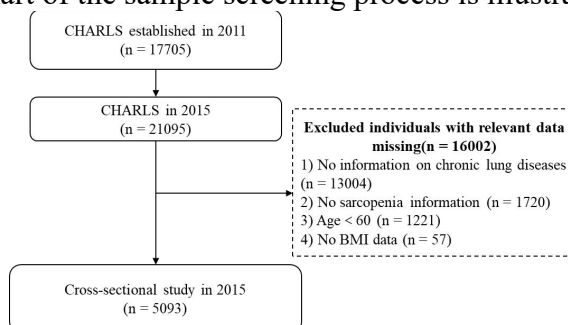


Figure 1 Flow chart of the screening process of respondents in the study

2.2 Assessment of Sarcopenia Status

Sarcopenia status was evaluated according to the AWGS 2019 consensus on sarcopenia diagnosis and treatment[1], which is consisted of three components: muscle strength, appendicular

skeletal muscle mass (ASM), and physical performance[16]. Handgrip strength (unit: kg) was measured in the dominant hand and non - dominant hand, with the participant squeezing a YuejianTM WL - 1000 dynamometer as hard as possible. Each participant was tested in duplicate for both hands by holding the dynamometer at a right angle (90°)[13]. The average value of the maximum force data of each hand was calculated. If the one of the participant's hands could not be measured, the maximum value of the other hand was recorded. According to AWGS 2019, the cut-off points of low grip strength for men and women were < 28 kg and < 18 kg., respectively.

Bio impedance analysis (BIA) and DXA measurement are popular in Asia to measure the ASM[16]. Nonetheless, these methods are rarely used due to the lack of diagnostic instruments in primary medical institutions. Studies have shown that the ASM equation model is in good agreement with the DXA calculation[9, 17]; thus, the physical measurement formula proposed in the research report can be used to estimate the ASM:

$$\text{ASM} = [0.193 \times \text{Weight (kg)}] + [0.107 \times \text{Height (cm)}] - [4.157 \times \text{Sex}] - [0.037 \times \text{Age}] - 2.631$$

The participant's weight was measured by a scale (OmronTM HN-286), while their height was measured by an altimeter (SecaTM213). First, the setting was adjusted: male = 1 and female = 2. The cut-off point of low muscle mass was the lowest 20% of individuals for each gender, which was later used to determine the height-adjusted muscle mass (ASM/ height²). In this study population, the ASM/Ht² values were < 6.86 kg/m² in men and < 4.60 kg/m² for women, respectively. Subsequently, the patient's muscle function was estimated by walking speeds and five-time chair stand tests[9]. The cut-off points for low muscle function set by the AWGS 2019 are as follows: five-time chair stand tests ≥ 12 s, a walking speed of $6 \text{ m} < 1.0 \text{ m/s}$, or a short physical performance battery (SPPB) score < 9 points[16].

Sarcopenia diagnosis is characterized by muscle mass plus low muscle strength or low physical performance. All these features are found in the case of severe sarcopenia. Meanwhile, possible sarcopenia includes muscle weakness or muscle dysfunction. After confirming their diagnosis, the participants were divided into three groups: no sarcopenia, possible sarcopenia, and sarcopenia. In this study, 160 (3.14%) participants were diagnosed with severe sarcopenia and placed in the sarcopenia group.

2.3 Evaluation of chronic lung disease

Based on CHARLS 2015, chronic lung disease was assessed by the following questions: 1) Did your doctor inform you that you have chronic lung diseases, such as chronic bronchitis or emphysema, cor pulmonale (excluding tumor or cancer)? Participants who answered "yes" were defined as having chronic lung disease.

2.4 Other covariates

According to prior knowledge, we also considered sociodemographic and health-related factors in our study. Sociodemographic variables included age, gender, and residence type (urban or rural). Health-related information included BMI, smoking and drinking status (yes or no), and 14 chronic diseases (hypertension, dyslipidemia, diabetes or elevated blood glucose, cancer and other malignant tumors, chronic lung disease, liver disease, heart disease, stroke, kidney disease, stomach or digestive system disease, emotional and mental diseases, memory-related diseases, arthritis or rheumatism, asthma). BMI was divided into three groups: underweight (BMI < 18.5 kg/m²), normal weight ($18.5 \text{ kg/m}^2 \leq \text{BMI} < 24 \text{ kg/m}^2$), and overweight or obese (BMI $\geq 24 \text{ kg/m}^2$). Meanwhile, the age groups used in this study were: 60 – 74, 75 – 89, and > 90 .

2.5 Statistical analysis

This paper analyzed the baseline characteristics of the population according to the sarcopenia status, and the continuous variables were presented as the mean \pm standard deviation (SD). When the continuous variables tally with the normal distribution, one-way ANOVA is used. If not, the

Kruskal Wallis test was utilized for data analysis[18, 19], Between-group comparisons were also performed (no sarcopenia, possible sarcopenia, and sarcopenia), and the categorical variables were presented as percentages (%).

Binary logistic regression was used to analyze the correlation between possible sarcopenia, sarcopenia, and chronic lung disease, which were expressed as odds ratios (ORS) and 95% confidence intervals (CI). In logistic regression analysis, the model controlled for all sociodemographic characteristics and health-related factors. The statistical analyses in this study were performed using SPSS version 25.0 (IBM, Inc., Chicago, IL) and R program (version 4.1.2). Statistical significance was considered when $p < 0.05$.

3. Results

3.1 Sociodemographic Data and Health-related Information

A total of 5093 participants were included in the analysis. Their sociodemographic data and health-related information were analyzed based on the respective groups (no sarcopenia, possible sarcopenia, and sarcopenia). The mean age of the participants was 72.0 (7.9 years), and 52.1% of the respondents were women. According to the AWGS 2019, the prevalence of possible sarcopenia and sarcopenia was 33.5% (1705/5093) and 11.3% (573/5093), respectively. Table 1 demonstrated that sarcopenia patients might exhibit the following characteristics compared to the non-sarcopenia groups: older age (79.4 vs. 69.8 years), males (54.8% vs. 46.6%), and reside in rural areas (88.5% vs. 79.2%). The prevalence of chronic diseases among the sarcopenia groups was higher ($P < 0.05$), and the differences in 14 chronic diseases among the three groups were statistically significant.

3.2 Correlation analysis of sarcopenia and chronic lung disease

In this study, the prevalence of chronic lung diseases in the general population, individuals without sarcopenia, possible sarcopenia, and sarcopenia were 13.9% (710/5093), 12.3% (353/2875), 14.8% (253/1705), and 20.3% (104/513), respectively ($P < 0.001$). Figure 2 illustrates the possible sarcopenia (OR: 1.30; 95% CI: 1.07-1.57, $P = 0.008$) and sarcopenia (OR: 1.36; 95% CI: 1.00-1.86, $P = 0.051$) were associated with the prevalence of chronic lung diseases(Figure 2).

3.3 Association analysis of low muscle mass alone and chronic lung disease

In the cross-sectional study, 2875 people (mean age: 69.8 ± 7.2 ; 53.4% female) did not suffer from sarcopenia; 506 (17.6%) individuals exhibited low muscle mass, while muscle strength and function were not low. The prevalence of chronic lung diseases was 11.3% (267/2369) in the population without any features of sarcopenia and 17.0% (86/506) in the population with only low muscle mass. Furthermore, only low muscle mass was not significantly associated with chronic lung diseases (OR: 1.40; 95% CI: 0.93 - 2.10, $P = 0.108$) (see Table 2).

Table 2 Association between low muscle mass and chronic lung disease based on CHARLS 2015

	Cases	Incidence rate (in every 1,000 individuals)	OR (95% CI)
Muscle mass (n = 2875)			
Reference (n = 2369)	267	11.3	1
Low muscle alone (n = 506)	86	17.0	1.40 (0.93, 2.10)

Reference: participants without sarcopenia.

Low muscle mass alone: low muscle mass with neither low grip strength nor slow physical performance. The model was adjusted for age, gender, residential area, smoking, drinking, body mass index, and comorbidities (including hypertension, dyslipidemia, diabetes, cancer, hepatic disease, heart disease, stroke, kidney disease, digestive system disease, emotional and mental diseases, memory-related diseases, arthritis, asthma).

4. Discussion

In the present study, we found the association of possible sarcopenia, sarcopenia, and chronic lung diseases among older Chinese by utilizing the data from CHARLS 2015. Both possible sarcopenia and sarcopenia, assessed using the AWGS 2019 algorithm, were independently associated with chronic lung diseases, and sarcopenia would increase the risk of chronic lung disease. Conversely, there was no correlation between low muscle mass and chronic lung diseases in the absence of low muscle strength and low physical performance.

This study found that sarcopenia prevalence was 11.3%, but this value varies between studies. For instance, Cruz-Jentoft et al.[20] reported that the prevalence of this disease in community residents ranged from 1% to 29%, but in the older population who require long-term care ranged between 10% and 33%. A study in South America involving 205 women reported that the prevalence of sarcopenia in the community was 2.4%.[21]. Nevertheless, an earlier domestic study that utilized the information from seven databases on the older Chinese population (> 58 years) found that the prevalence of sarcopenia was about 10%, similar to the current study.[22] Therefore, race, living conditions, and different diagnostic criteria potentially contributed to the discrepancies between studies. Tian et al.[23] reviewed 17 observational studies in China and reported that the prevalence of sarcopenia diagnosed based on the AWGS 2014 among 18841 elderly (> 60 years) was 8%, which was lower than EWGSOP (10%) and IWGS (20%). As the measurement of muscle mass is crucial for sarcopenia, Beaudart et al.[24] used the EWGSOP to compare the morbidity among older Chinese over 65 years old and found that the prevalence measured by BIA and DXA technology was 12.8% and 21%, respectively. This finding may be attributed to the BIA method that yields higher estimates of muscle mass, thus, lowering the estimates of sarcopenia prevalence.

This study found that sarcopenia increased the risk of chronic lung diseases, particularly for the sarcopenia group, where the risk was 1.36 times higher than the group without sarcopenia. Currently, there is a lack of studies on the association between sarcopenia and chronic lung diseases. Walter et al.[25] included 9637 studies from Europe, Asia, and North and South America, and found that sarcopenia was prevalent in a considerable proportion of COPD patients, accompanied by adverse effects. Meanwhile, Wu et al.[26] studied 6172 elderly (> 60 years) and found that chronic lung diseases were associated with a higher risk of possible sarcopenia. In addition, Sarah et al.[8, 27] enrolled 622 outpatients in the UK and found that sarcopenia affected approximately 15% of COPD patients by impairing physical function and health status. There is a complex association between sarcopenia and chronic lung diseases which is affected by multiple pathophysiological changes in sarcopenia patients, including muscle mitochondrial dysfunction, oxidative stress, excessive inflammatory state, and various metabolic disorders (insulin resistance and non-alcoholic fatty liver disease).[28-30] Certain lifestyles, such as malnutrition and physical inactivity[31, 32], could also exacerbate this condition. Tunsupon et al.[33, 34] found that the sarcopenia index (SI) can evaluate the risk of acute exacerbation in COPD patients by utilizing a queuing system. Nevertheless, it is essential to further explore the interaction between sarcopenia and chronic lung diseases.

Sarcopenia is a common disease of the older population that is burdening society heavily. Considering the aging population in China, the geriatrics of the Chinese Medical Association issued the Chinese expert consensus in 2021 on diagnosing and treating older patients with sarcopenia. Moreover, the global initiative for chronic obstructive pulmonary disease published the global strategy for diagnosing, treating, and preventing this condition in 2022. These initiatives directed

institutions and health organizations to prevent and intervene in sarcopenia and chronic lung diseases. Based on this study findings, sarcopenia identification during health examination and routine clinical practice in the community are promising in identifying those at high risk of developing chronic lung diseases.

The current study also demonstrated the association between possible sarcopenia and chronic lung diseases, assessed by the AWGS 2019 algorithm. The prevalence of chronic lung diseases were significantly increased in persons with possible sarcopenia. Because sarcopenia diagnosis comprises three factors: muscle strength, ASM, and physical performance. the study found no significant correlation between low muscle strength alone and chronic lung diseases. In addition, this finding indicated that different states of sarcopenia contributed differently to the prevalence of chronic lung diseases, thus, providing a feasible window for early disease intervention.

This study has several strengths. As the data was obtained from CHARLS 2015, this study had a large sample and national representation; hence, the recent discoveries carry a general significance. Moreover, this study provided new evidence for the AWGS 2019 feasibility and efficacy in screening sarcopenia, which is crucial for the early intervention of chronic lung disease.

Howwve, there are several limitations in the current study. First, the lack of information on SPPB scores may lead to a deviation in sarcopenia classification. Secondly, the walking speed recorded in the CHARLS database is based on the 2.5 m round-trip of individuals at normal speed rather than the 6 m standard walking speed proposed by the AWGS 2019. Nevertheless, a systematic review of 48 studies reported that walking distance did not affect walking speed among the elderly[31]. Furthermore, Wu et al.[26] demonstrated that the average walking speed of individuals with and without sarcopenia in CHARLS 2015 was consistent with previous domestic studies. Therefore, the walking speed for 2.5 m is credible. Thirdly, the diagnosis of chronic diseases such as chronic lung disease in this study was based on a questionnaire without referring to medical records; thus, the diagnosis may be biased. Fourth, other potential confounding factors, such as sleep quality and dietary habits, may have impacted the results despite considering numerous factors based on the literature. Fifth, as asthma was evaluated separately in the CHARLS questionnaire, asthma was not included in this study, thus, potentially underestimating the prevalence of chronic lung diseases. Nevertheless, this study findings provide important references for future related research. Future studies could incorporate sarcopenia assessment in the community health examination and routine clinical practice of the older Chinese to identify and administer early sarcopenia intervention. This precautionary measure could reduce the incidence of chronic lung diseases among the older Chinese population.

Table 1 Demographic data of 5093 participants based on their sarcopenia status based on CHARLS 2015

Variables	Total (n = 5093)	Non-sarcopeni a (n = 2875)	Possible sarcopenia (n = 1705)	Sarcopenia (n = 573)	P-value
Age (years)	72.0 ± 7.9	69.8 ± 7.2	73.5 ± 7.2	79.4 ± 8.1	0.004
60-74	66.3	76.2	60.3	30.8	< 0.001
75-89	31.1	22.7	37.2	58.1	
≥ 90	2.6	1.1	2.5	11.1	
Gender (%)					
Male	47.9	46.6	48.1	54.8	< 0.001
Female	52.1	53.4	51.9	45.2	
Residential areaa (%)					
Urban	20.2	20.5	22.1	11.1	< 0.001
Rural	79.8	79.2	77.7	88.5	
Smokinga (%)					

Yes	41.3	40.6	40.2	49.1	< 0.001
No	58.7	59.3	59.6	50.7	
Drinkinga (%)					
Yes	45.7	45.6	45.2	47.4	< 0.001
No	54.2	54.4	54.8	52.4	
BMI (%)					
Underweight	7.0	5.7	0.1	37.4	< 0.001
Normal weight	38.2	37.3	32.5	62.4	
Overweight or obesity	54.8	57.0	67.4	0.2	
Comorbidities (%)					
Hypertension	27.3	25.3	29.7	29.8	< 0.001
Dyslipidaemia	10.1	10.3	10.7	6.4	< 0.001
Diabetes	6.7	6.3	7.8	5.1	< 0.001
Cancer	1.1	1.1	0.9	1.8	< 0.001
Chronic lung disease	13.9	12.3	14.8	20.3	< 0.001
Hepatic disease	4.9	4.7	4.9	6.0	< 0.001
Heart disease	12.8	12.1	12.8	15.2	< 0.001
Stroke	11.4	10.5	11.7	13.6	< 0.001
Kidney disease	8.2	7.5	9.5	7.6	< 0.001
Digestive system disease	26.3	25.9	25.7	30.4	< 0.001
Emotional and mental disorders	1.8	1.4	1.9	4.1	< 0.001
Memory-related disease	1.7	1.3	1.8	3.1	< 0.001
Arthritis	38.1	37.0	39.8	37.8	< 0.001
Asthma	4.2	3.9	4.4	5.5	< 0.001
ASM/Ht2 (kg/m2)	8.5 ± 1.3	8.6 ± 1.2	8.7 ± 1.2	7.3 ± 1.0	< 0.001
Handgrip strength(kg)	27.3 ± 9.9	30.5 ± 8.8	24.1 ± 9.7	20.3 ± 9.1	< 0.001
Gait speed (m/s)	0.8 ± 0.2	0.8 ± 0.2	0.7 ± 0.2	0.6 ± 0.2	< 0.001
Five-time chair stand test (s)a	9.8 ± 4.5	8.4 ± 2.3	11.6 ± 5.5	11.5 ± 6.3	< 0.001

Data are shown as means ± SD for age, ASM/Ht2, handgrip strength, gait speed, five-time chair stand test, median (interquartile range) for gender, residential area, smoking, drinking, BMI, comorbidities.

a Missing data: 15 for residential area, 10 for smoking, 4 for drinking, 149 for five-time chair stand test.

ASM: appendicular skeletal muscle; ASM/Ht2: height-adjusted muscle mass; BMI: body mass index.

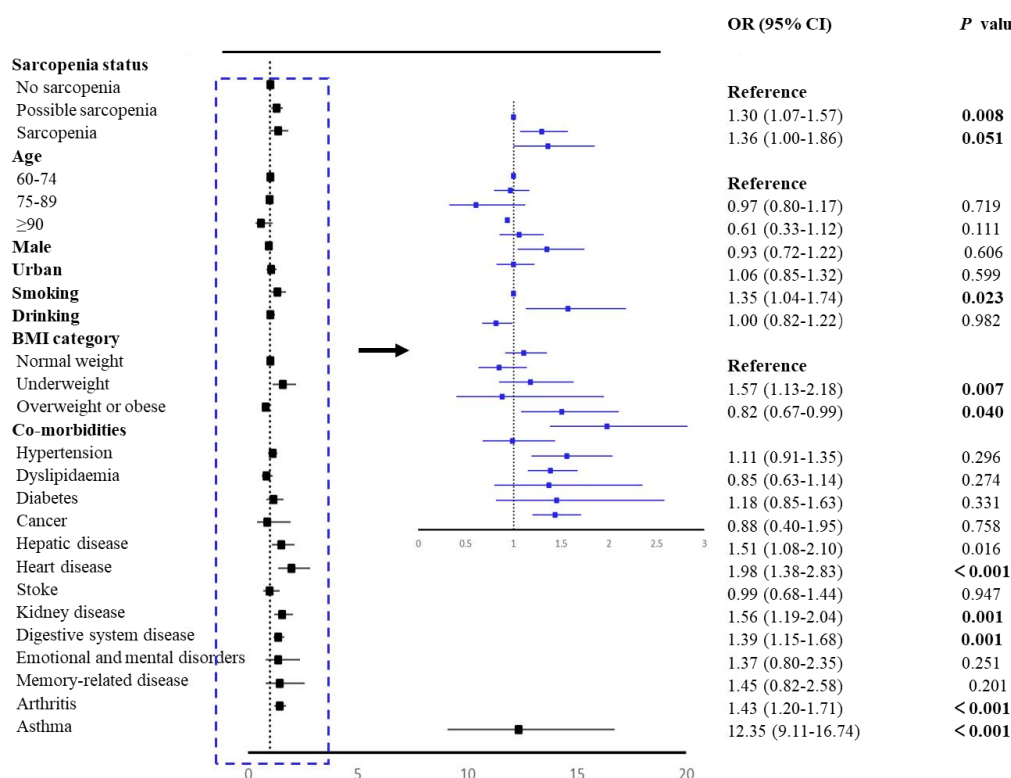


Figure 2 Cross-sectional association between sarcopenia and chronic lung diseases

Forest plots show odds ratio (OR) and 95% CI for chronic lung diseases adjusted for age, gender, residential area, smoking, drinking, body mass index, and comorbidities (hypertension, dyslipidemia, diabetes, cancer, hepatic disease, heart disease, stroke, kidney disease, digestive system disease, emotional and mental diseases, memory-related diseases, arthritis, asthma).

5. Conclusion

This study discovered a correlation between sarcopenia and chronic lung disease among the older Chinese (> 60 years) population. Therefore, preventing and/or improving both possible sarcopenia and sarcopenia may be beneficial for reducing the prevalence of chronic lung diseases and promoting healthy aging among older Chinese.

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