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Prevalence and factors associated with dynapenia among middle-aged and elderly people in rural southern China

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ABSTRACT

To estimate the prevalence of dynapenia and examine potential risk factors for dynapenia using a sample of rural middle-aged and elderly Chinese. A cross-sectional study of 253 Chinese adults aged 50 years and older was conducted from June to August in 2022 in Nanjing. A questionnaire was used to collect data on all socioeconomic variables. Body weight, height, body fat percentage, grip strength, waist circumference, calf circumference, and gait speed were measured. The prevalence of dynapenia was 69.6 %, 62.3 % in men and 72.7 % in women respectively. Binary logistic regressions indicated significant associations between dynapenia and age (odds ratio [OR] = 2.59; 95 % confidence interval [CI] 1.63, 4.12; $p < 0.001$), educational level (OR = 0.55; 95 % CI 0.38, 0.80; $p = 0.002$). Dynapenia was prevalent among rural middle-aged and elderly people in southern China. Age and lower education level were both associated with dynapenia. Nutrition and physical activity should be strongly recommended as important strategies to maintain and improve muscle strength.

1. Introduction

Sarcopenia is associated with falls, osteoporosis and hospitalization (Chen et al., 2020). With a rising population of older adults, sarcopenia will bring a heavy burden to the medical system. By 2050, people older than 65 years are estimated to account for 16 % of the population (Knight et al., 2019). Considering a progressive loss of leg muscle mass at a rate of 1–2 % per year and a decline in strength at a rate of 1.5–5 % per year after the age of 50 years, muscle health of middle-aged adults should also be paid attention to (Cruz-Jentoft et al., 2019).

Dynapenia was proposed to define the age-related loss of muscle strength and power (Clark and Manini, 2008). When predicting adverse health outcomes, muscle strength is superior to muscle mass (Borim et al., 2019; Rossi et al., 2019; Noh and Park, 2020). Additionally, dynapenia negatively affects medical conditions, including metabolic syndrome, dementia and mortality (Cruz-Jentoft et al., 2019). In 2019, the European Working Group on Sarcopenia in Older People (EWGSOP) revised the European consensus and suggested that low muscle strength overtook the role of low muscle mass as a principal determinant of sarcopenia (Cruz-Jentoft et al., 2019), and dynapenia deserves more attention.

Many studies showed that rural residents were weaker in muscle strength, and rural elders were more vulnerable to sarcopenia than urban elders (Schaap et al., 2018; Zeng et al., 2016). However, few articles report the prevalence of dynapenia in the Chinese population, and most focus on community-dwelling adults (Chen et al., 2022; Wang et al., 2022).

Therefore, this study aimed to estimate the prevalence of dynapenia and examine potential risk factors using a sample of rural middle-aged and elderly Chinese.

2. Methods

2.1. Study design and participants

From June to August in 2022, this population-based cross-sectional study was carried out in 5 villages of Nanjing city, located in southern China. Adults aged 50 years and older were recruited in this study.

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Participants with the following conditions were excluded: (i) unable to communicate with researchers or grant informed consent; (ii) unable to perform grip strength test or the 6-meter gait test; (iii) unable to stand for the measurement. This study was approved by the Ethics Committee of Nanjing Medical University (Ethical code: 2022–818). All the participants agreed to participate in our study by signing an informed consent form.

A questionnaire was used to collect data on all socioeconomic variables: gender, age, education level, marital status and living habits. All questionnaires were written by properly trained investigators who conducted face-to-face interviews.

2.2. Measurement

Weight and height were measured using an ultrasonic stadiometer and a digital floor scale, respectively. Body fat percentage (BF%) was carried out using a bioelectrical impedance meter (Omron Body Fat Analyzer HBF-306; Omron, Bannockburn, Illinois). BF% $\geq$ 35 % for women and BF% $\geq$ 25 % for men were defined as obesity. Grip strength was measured with a grip strength meter (EH201R, Xiangshan, Guangdong, China). Measurements were performed with participants in sitting position and elbow joint at 90°. The dominant hand was tested twice and higher value was recorded for analysis. Low muscle strength was defined as grip strength < 26 kg or < 18 kg for males and females, respectively. Waist circumference (WC) was measured at the midpoint between the lower ribs and the ilium. WC $\geq$ 80 cm for women and WC $\geq$ 85 cm for men were defined as obesity. Mean calf circumference (CC) was measured at the widest level of both calves in a standing position. The cutoff value was $\geq$ 33 cm for women and $\geq$ 34 cm for men. Muscle mass was estimated by the appendicular skeletal muscle mass (ASM) using a previously validated equation in a Chinese population (Yang et al., 2017). The appendicular skeletal muscle index (SMI) was calculated using the ASM divided by the square of the height in metres (SMI = ASM/height^2). The low muscle mass was defined by the SMI, with the exclusion based on 20 % of the lowest percentile of the population distribution, representing the SMI of < 4.75 kg/m^2 for women and 6.70 kg/m^2 (Yang et al., 2017) for men. Gait speed was assessed through the mean of two attempts to walk a 6-meter path at the usual pace. Low gait speed was defined as < 1 m/s for both males and females. Low muscle function was defined as low grip strength and/or gait speed. All measurements were carried out by the same experienced researcher. Dynapenia was defined as low muscle function with normal muscle mass. Participants with normal muscle function were classified as non-dynapenia.

2.3. Statistical analysis

The data were analyzed by SPSS 21. Differences between participants' characteristics were analyzed using chi-square tests and Student's t-tests. Comparisons between people with or without dynapenia were presented using Pearson's chi-square test or Fisher's exact test, and factors with a p value < 0.1 were selected for a subsequent binary logistic regression analysis. Statistical significance was assessed at a two-sided p value < 0.05.

Table 1
Descriptive characteristics of 253 Chinese adults aged 50 years or older in 2022.

Characteristics		Total (N = 253)		Male (n = 77)		Female (n = 176)		*P value*
		n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	
Age	50 ~ 59	59	23.3	10	13.0	49	27.8	0.015*
	60 ~ 69	70	27.7	20	26.0	50	28.4	
	70 or more	124	49.0	47	61.0	77	43.8	
Educational level	None	89	35.2	18	23.4	71	40.3	0.018*
	1 ~ 5 years	89	35.2	30	39.0	59	33.5	
	6 ~ 8 years	52	20.6	17	22.1	35	19.9	
	> 8 years	23	9.1	12	15.6	11	6.3	
Marital status	Married	176	69.6	58	75.3	118	67.0	0.188
	Unmarried†	77	30.4	19	24.7	58	33.0	
Living alone	Yes	65	25.7	22	28.6	43	24.4	0.488
	No	188	74.3	55	71.4	133	75.6	
Smoking	Never smoke	207	81.8	34	44.2	173	98.3	<0.001*
	Ex-smoke	15	5.9	14	18.2	1	0.6	
	Current smoke	31	12.3	29	37.7	2	1.1	
Drinking	Never drink	199	78.7	41	53.2	158	89.8	<0.001*
	Ex-drink	10	4.0	8	10.4	2	1.1	
	Current drink	44	17.4	28	36.4	16	9.1	
Sleeping duration	≤6h	85	33.6	24	31.2	61	34.7	0.549
	6 ~ 8 h	110	43.5	32	41.6	78	44.3	
	≥8h	58	22.9	21	27.3	37	21.0	
BMI	Under weight	11	4.3	6	7.8	5	2.8	0.230
	Normal weight	131	51.8	35	45.5	96	54.5	
	Overweight	93	36.8	31	40.3	62	35.2	
	Obesity	18	7.1	5	6.5	13	7.4	
WC	Normal	55	21.7	24	31.2	31	17.6	0.016*
	Obesity	198	78.3	53	68.8	145	82.4	
CC	Normal	218	86.2	42	54.5	176	100.0	<0.001*
	Low	35	13.8	35	45.5	0	0.0	
BF%	Non-obesity	111	43.9	18	23.4	93	52.8	<0.001*
	Obesity	142	56.1	59	76.6	83	47.2	
Gait speed, m/s		1.01	0.24	0.98	0.26	1.03	0.23	0.198
grip strength, kg		17.88	7.38	23.90	8.44	15.24	4.95	<0.001*
SMI, kg/m^2		6.56	1.07	7.73	0.77	6.05	0.72	<0.001*

BMI,Body mass index; WC, Waist circumference; CC, calf circumference; BF%, Body fat percentage; SMI, appendicular skeletal muscle index.
*p < 0.05.
†Including divorce, separation by any reason, and single.
P values were derived from the Student's *t*-test, χ^2 test or the Fisher's exact test.

3. Results

The study included 253 participants (176 women and 77 men). The mean age of the participants was 68.6 ± 10.2 years, and the mean BMI was 24.7 ± 3.6 kg/m^2. The majority of the participants were married, non-smokers, and non-drinkers. The age, educational level, smoking, drinking, WC, CC and BF% were different between males and females (Table 1).

14 (5.5 %) participants were sarcopenic (i.e. had low muscle mass, low muscle strength and/or low muscle function), and excluded from further analysis. The prevalence of dynapenia was 69.6 %, 62.3 % in men and 72.7 % in women respectively. Table 2 showed the results of the univariate analysis. The participants with dynapenia were older than those without dynapenia. Nearly half of 50–59 group had dynapenia, and the prevalence of those aged 70 or more was up to 91.9 %.

Compared with those without dynapenia, more participants with dynapenia were without partner, never drinker, and had lower educational level.

The results of the binary logistic regressions were provided in Fig. 1. Significant associations between dynapenia and age (odds ratio [OR] = 2.59; 95 % confidence interval [CI] 1.63, 4.12; $p < 0.001$), educational level (OR = 0.55; 95 % CI 0.38, 0.80; $p = 0.002$) were showed.

4. Discussion

In our study, the prevalence of dynapenia among rural middle-aged and elderly people was 69.6 %, which was higher than others. The prevalence of 10.3 %, 17.2 %, and 33.9 % were observed among Japanese, Brazilians and Mexicans, respectively (Kobayashi et al., 2020; Borges et al., 2020; Rodríguez-García et al., 2018). The prevalence found in our study was also higher than other reports among Chinese community-dwelling old adults (11.11 % or 46.0 %) (Chen et al., 2022; Wang et al., 2022). These large differences in prevalence could be partially attributed to age, ethnicity, diagnosis criteria and region.

Consistent with other studies (Borges et al., 2020), our findings demonstrated that dynapenia was positively associated with age, and negatively associated with education level. Our study indicated that BMI was not an associated factor of dynapenia. Although some reports evidenced a similar link to ours (Wang et al., 2022), a study in Brazil found dynapenia was negatively associated with BMI. Another study reported that alcohol consumption was associated with decreased risk of dynapenia (Wu et al., 2021). Although we achieved the same result by univariate analysis, logistic regression analysis did not indicate alcohol consumption is a factor in dynapenia. As limited studies focus on it and the findings have been inconsistent, further studies are needed to ensure the relationship between alcohol consumption, BMI and dynapenia.

Considering a decline of 1.5 ~ 5 % per year in muscle strength beyond the age of 50 years, early and effective interventions should be taken. In view of the fact that rural middle-aged and elderly adults have lower education level, and higher education level is a protective factor for dynapenia, health education should be conducted to inform them of the consequence and preventive measures of dynapenia. Most of the elderly cannot use smart phones, especially in rural areas, so it is suggested that community organizations, hospitals or medical colleges take the lead in promoting health communications.

Nutrition and physical activity are two important behavioral factors to maintain muscle strength. Combined exercise and nutrition interventions improved muscle strength to a greater degree than exercise or nutrition alone (Buckinx and Aubertin-Leheudre, 2019). Protein or amino acid supplementation, and vitamin D supplementation can bring

Table 2
Characteristics of groups according to dynapenia status among 239 Chinese adults aged 50 years or older in 2022.

Characteristics		Non-dynapenia (N = 63)		Dynapenia (N = 176)		χ^2	*P value*
		n	%	n	%		
Age	50 ~ 59	31	52.5	28	47.5	39.626	<0.001*
	60 ~ 69	22	32.4	46	67.6		
	70 or more	10	8.9	102	91.9		
Gender	Male	22	31.4	48	68.6	1.310	0.252
	Female	41	24.3	128	75.7		
Educational level	None	9	10.7	75	89.3	39.358	<0.001*
	1 ~ 5 years	20	24.1	63	75.9		
	6 ~ 8 years	17	34.7	32	65.3		
	> 8 years	17	73.9	6	26.1		
Marital status	Married	54	31.8	116	68.2	8.862	0.003*
	Unmarried†	9	13.0	60	87.0		
Living alone	Yes	53	29.3	128	70.7	3.280	0.070
	No	10	17.2	48	82.8		
Smoking	Never smoke	47	23.9	150	76.1	5.185	0.075
	Ex-smoker	4	26.7	11	73.3		
	Current smoker	12	44.4	15	55.6		
Drinking	Never drink	43	22.9	145	77.1	6.064	0.048*
	Ex-drinker	3	30.0	7	70.0		
	Current drinker	17	41.5	24	58.5		
Sleeping duration	≤6h	19	22.9	64	77.1	1.009	0.604
	6 ~ 8 h	30	29.4	72	70.6		
	≥8h	14	25.9	40	74.1		
BMI	Under weight	2	100.0	0	0.0	5.303	0.137
	Normal weight	30	23.8	96	76.2		
	Overweight	27	29.0	66	71.0		
	Obesity	4	22.2	14	77.8		
WC	Normal	13	31.0	29	69.0	0.554	0.457
	Obesity	50	25.4	147	74.6		
CC	Normal	56	26.5	155	73.5	0.030	0.862
	Low	7	25.0	21	75.0		
BF%	Non-obesity	29	29.3	70	70.7	0.749	0.387
	Obesity	34	26.4	106	73.6		

BMI,Body mass index; WC, Waist circumference; CC, calf circumference; BF%, Body fat percentage.
*$p < 0.05$.
†Including divorce, separation by any reason, and single.

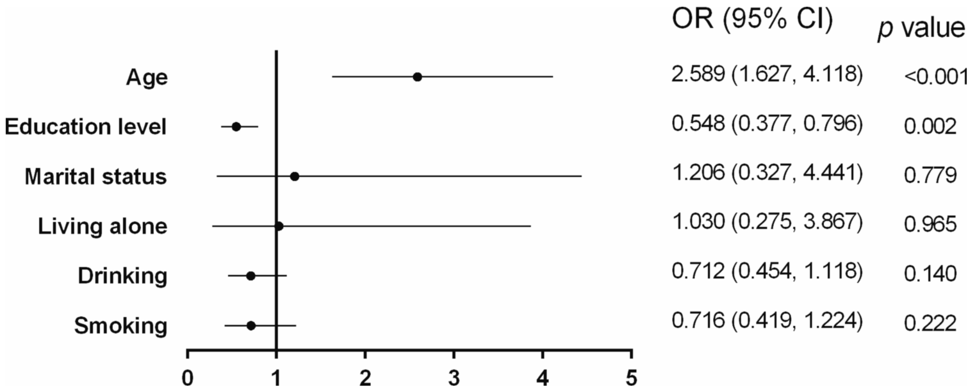

Fig. 1. Estimated odds ratios (OR) with 95 % confidence intervals for dynapenia-associated factors among 239 Chinese adults aged 50 years or older in 2022.OR, odds ratio; CI,confidence interval.

benefits in the prevention of muscle strength decline (Buckinx and Aubertin-Leheudre, 2019), other studies suggested that creatine supplementation, adequate intakes of certain minerals (Mg, Se, Fe, P, Zn and Ca), long-chain polyunsaturated fatty acid, antioxidants increases aging muscle strength (Candow et al., 2019; Das et al., 2021). Furthermore, both aerobic exercise and resistance training can reduce the decline in muscle strength with age, especially for high-intensity resistance training (Xie et al., 2020). Lack of fitness equipment is the main barrier to engaging in physical activity among rural middle-aged and elderly Chinese. Thus, facilities around residential areas are essential. In addition, physical fitness tests should be conducted on local groups, and scientific and rigorous exercise methods, exercise intensity, exercise duration and exercise programs should be selected according to physical conditions of the elderly, especially those who have chronic diseases, so as to reduce the risk of dynapenia and avoid bodily injury.

4.1. Strengths and limitations

To the best of our knowledge, this study is the first to estimate the prevalence of dynapenia in rural middle-aged and elderly Chinese. On the contrary, this study has some limitations to discuss. First, due to the cross-sectional design of the study, causality cannot be inferred. Second, we did not collect physical activity information. Nevertheless, a recent review discovered that rates of activity were low in rural areas (Schmidt et al., 2022). Third, we estimated the muscle mass by an equation instead of dual X-ray absorpometry or bioelectrical impedance analysis. Because these instruments are difficult to use in rural areas. Also, estimation formulas for appendicular muscle mass using anthropometric values have been reported, and its validity has been confirmed (Wen et al., 2011; Hu et al., 2017). Because of uneven economic development in different regions of China, further research regarding dynapenia in more rural districts is warranted.

5. Conclusion

In summary, we found that dynapenia was prevalent among rural middle-aged and elderly people in southern China. Age and lower education level were both associated with dynapenia. This study highlights the role of earlier health education in the prevention of dynapenia among rural residents. Nutrition and physical activity should be strongly recommended as important strategies to maintain and improve muscle strength.

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Ethics approval

All procedures involving human subjects were approved by the Research Ethics Committee of Nanjing Medical University (Ethical code: 2022–818).

Statement of human and animal rights

This study was conducted according to the guidelines laid down in the Declaration of Helsinki.

Informed consent

All participants provided written informed consent.

CRediT authorship contribution statement

Wanqing Zhou: Conceptualization, Data curation, Formal analysis, Investigation, Writing – original draft. **Jiali Tong:** Conceptualization, Data curation, Formal analysis, Investigation, Writing – original draft. **Zhiyu Wen:** Conceptualization, Investigation. **Mao Mao:** Conceptualization, Investigation. **Yimin Wei:** Conceptualization, Investigation. **Xiang Li:** Conceptualization, Investigation. **Ming Zhou:** Conceptualization, Writing – review & editing. **Hua Wan:** Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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