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The prevalence of sarcopenia in very old individuals according to the European consensus definition: insights from the BELFRAIL study

Delphine Legrand, Bert Vaes, Catharina Matheï, Christian Swine, Jean-Marie Degryse

IRSS Institute of Health and Society, Université Catholique de Louvain (UCL), Brussels, Belgium

Address correspondence to: D. Legrand. Tel: +32 2 7643466; Fax: +32 2 7643470. Email: delphine.legrand@uclouvain.be

Abstract

Background: the prevalence of sarcopenia varies widely between studies. The objective of this study was to assess the prevalence of sarcopenia in a representative sample of persons aged 80 years and older according to the European Working Group on Sarcopenia in Older People (EWGSOP) algorithm and the proposed cut-off values. A secondary aim was to investigate the relationship between different individual criteria and low physical performance capacity.

Methods: baseline data of the prospective BELFRAIL study (BF$_{C80}$+) were analysed. Sarcopenia status was determined according to the EWGSOP guidelines. The skeletal muscle mass index (SMI) was assessed according to bioelectrical impedance. Muscle strength and muscle performance were evaluated according to grip strength and the modified short physical performance battery (SPPBm). A logistic regression analysis was performed.

Results: according to the EWGSOP algorithm, 12.5% of the participants were classified in the sarcopenia group. Sixty percent of the female participants had muscle strength values below the cut-off and 70% had low SPPBm values. In males, these prevalence values were 49.5% for grip strength and 39.7% for SPPB. The logistic regression analysis showed that low SPPBm was associated with grip strength (OR: 0.88, 95% CI: 0.84–0.92) independent of SMI.

Conclusion: in a population-based sample of the very old the prevalence of sarcopenia according to the EWGSOP algorithm is similar to the prevalence of sarcopenia with SMI as a single criterion. A large number of participants with a sufficient SMI value showed low muscle strength and/or a poor SPPBm score. A low SPPBm was associated with grip strength but not with SMI.

Introduction

Sarcopenia has been described as the age-related decrease in muscle mass [1]. Over the last decade, this definition has evolved, and a qualitative dimension was added to focus on decreases in muscle strength and muscle function [2]. The main consequences of the loss of muscle mass and muscle strength in older people include the limitation of physical performance and mobility disability, which increase the risk of falls, hospitalisations, dependency and mortality [2], but it remains unclear whether a decline in physical performance results from the loss of muscle mass and/or the functional quality of muscle [3].

Several studies have shown that muscle strength declines more rapidly than muscle mass [4–6] particularly in subjects aged 80 years and older [7]. Furthermore, the age-associated loss of strength (dynapenia) is not completely explained by the loss of muscle mass [8]. Moreover, longitudinal studies have found that poor handgrip strength represents a predictor of functional disability [9, 10] and mortality [11] and that handgrip strength and/or physical performance capacity are better predictors of clinical outcome than low muscle mass [12–14].

Different techniques are used to evaluate sarcopenia, but none of these consider both quantitative (muscle mass) and qualitative (muscle strength and physical performance) dimensions of the condition [3]. The prevalence of sarcopenia varies widely between studies (range 10–50%) and is difficult to compare because the methods used and the selected diagnostic criteria often differ [15]. Therefore, Bijlsma *et al.* recently advocated the formulation of a consensus definition to make studies comparable and ready for implementation in clinical care [15]. The European Working Group on Sarcopenia in Older People (EWGSOP) has developed a practical definition and consensus diagnostic criteria for sarcopenia, whereby measurable variables are summarised to define sarcopenia cut-off points based on measurements of muscle strength, muscle mass and physical performance [13].

We assessed the prevalence of sarcopenia in a representative sample of very old community-dwelling individuals according to the EWGSOP algorithm and the proposed cut-off values of single criteria and investigated the relationship between the different individual criteria and low physical performance capacity, one of the most important consequences of sarcopenia.

Methods

Study population

The BELFRAIL study (BF$_{C80+}$) was designed as a prospective, observational, population-based cohort study to evaluate subjects aged 80 years and older living in Belgium. The study protocol and methods have previously been described in detail [16]. In short, between November 2008 and September 2009, 567 individuals were included in the BF$_{C80+}$ [16]. Only three exclusion criteria, including known severe dementia, palliative situations and medical urgency, were used. All of the participants in the study gave informed consent and the Biomedical Ethics Committee of the Medical School of the Université Catholique de Louvain (UCL) approved the study.

Clinical characteristics

The general practitioner (GP) recorded background variables such as the level of education, living at home (alone or with someone) and whether care was provided at home. The medical history, including the presence of arthritis, osteoarthritis, osteoporosis, thyroid problems, anaemia, asthma, chronic obstructive pulmonary disease, Parkinson's disease, cancer, knee or hip prosthesis, hypertension, hyperlipidaemia, history of angina pectoris or myocardial infarction, known cardiomyopathy, history of transient ischaemic attack, diabetes and cerebro-vascular accident, peripheral arterial disease, history of decompensated heart failure, atrial fibrillation, valvular disease and history of oedema of the lower extremities, was recorded. The sum of the positive responses

from this medical history was used for further analyses. A clinical research assistant registered the cognitive function using the Mini-Mental State Examination (MMSE) [17], with scores ranging from 0 to 30 points. The 15-item Geriatric Depression Scale (GDS-15) [18] was used to screen for depression. Functional limitations were assessed by asking the respondents the degree of difficulty they had with six activities of daily living (ADL) [19] with scores ranging from 6 to 30. Information on physical activity was obtained using the LASA Physical Activity Questionnaire (LAPAQ) [20]. Gender and season adjusted quartiles of the total LAPAQ score were determined.

Criteria of sarcopenia

The modified standard physical performance battery (SPPBm) included timed measures of walking speed, rising from a chair and maintaining balance in a tandem stand [21]. For the walking test, participants in standing position were asked to walk 3 m, turn around and walk back the 3 m as quickly as possible. For the chair-stand test, respondents were asked to fold their arms across their chest and to stand up from a sitting position and sit down five times as quickly as possible. For the ability to maintain balance, the participants were asked to put the heel of one foot in front of the other and to stand still as long as possible [16].Those individuals who could not complete a task were assigned a score of 0, and those who completed the tasks were assigned scores of 1–4, corresponding to the quartiles of time required to complete the task, where the best time received a score of 4. For the balance task a score of 0 was assigned to those who were unable to perform the test, and a score of 1 was assigned to those who tried but were unable to maintain the tandem stand for >1 s. For those maintaining a tandem stand for >1 s but <3 s, a score of 2 was assigned, 3 if they could stand for 3–9 s and 4 if they maintained the tandem stand for 10 s or more [21]. The performance total score was calculated by summing the scores and ranged between 0 and 12. It was assumed that the same cut-off values could be used for the SPPBm as for the standard SPPB. A score of ≤8 and <0.8 m/s for gait speed, according to criteria from the EWGSOP [13].The skeletal muscle mass index (SMI) was calculated as the muscle mass in kilograms divided by the square of the height in meters (kg/m²). The muscle mass was estimated using the formula developed by Janssen *et al.* [22] and was measured using BIA (BODYSTAT 15MDD device, Bodystat LTD). Patients wearing a pacemaker were excluded from the analysis. The SMI cut-off point identifying a risk for sarcopenia was 8.87 kg/m² for men and 6.42 kg/m² for women [13, 23]. BIA only became available for use at 6 months after the onset of the research project; once the equipment became available, all the patients were included ($n = 288$, 50.8%). Grip strength was measured three times in the dominant hand using a JAMAR® Plus digital handheld dynamometer. The maximum value was used in all further calculations. Strength values <20 kg for women and <30 kg for men were used as cut-off points for the definition of sarcopenia [12, 13]. The algorithm provided

by the EWGSOP was used to determine whether the study individuals were sarcopenic [13]. In addition, the proportion of subjects with sarcopenia in our cohort (BF$_{C80+}$) was calculated according to single criteria cut-off values for SMI, SPPBm and grip strength, as referenced in the European consensus [13].

Statistical analysis

Continuous data are presented as the means (±SD) or median and inter-quartile range. The characteristics of the study participants with and without sarcopenia were compared using Student's *t*-test for continuous variables or the Chi-square test for categorical variables. A logistic regression analysis was performed to assess the associations between grip strength and SMI and low SPPBm or gait speed. The analyses were controlled for weight and gender. SPSS 16.0 (SPSS, Inc., Chicago, IL, USA) was used for the data analysis.

Results

A total of 288 participants, including 185 women (64.2%) and 103 men (35.8%), with a mean age of 85.0 ± 3.8 and 84.6 ± 3.4 years, respectively, were analysed. According to the EWGSOP algorithm, 12.5% ($n = 36$) of the study participants were classified in the sarcopenia group (SG) (Figure 1). The characteristics of the BF$_{C80+}$ study participants, arranged according to sarcopenia status, are shown in Table 1. The body weight and BMI values were significantly lower in the SG than in the non-sarcopenia group (NSG), and the proportion of subjects in the SG with a low LAPAQ score was significantly higher than that in the NSG (44.4 versus. 22.6%, respectively). However, we found no significant differences between the two groups regarding gender, age, level of education, care at home, number of diseases, ADL and GDS-15.

Looking at the different criteria separately, the majority of women and men (96.2 and 82.5%, respectively) had a gait speed of <0.8 m/s. Sixty percent of the female participants had grip strength values below the cut-off, 70% had low SPPBm values and only 12.4% had a low SMI. In males, these prevalence values were 49.5% for grip strength, 44.7% for SPPBm and 14.6% for SMI (Supplementary data are available in *Age and Ageing* online, Appendix Table S1).

Among the participants with SMI values above the cut-off value, 38.8% ($n = 97$) had both a grip strength and SPPBm score below the cut-off, 14.8% only had grip strength values and 20.4% only SPPBm scores below the cut-off (Table 2). In the same group, 51.2% ($n = 128$) had both grip strength and gait speed scores below the cut-off, 2.4% only grip strength values and 40.4% only gait speed scores below the cut-off (Table 2).

For the logistic regression analysis SPPBm was used as the dependent variable and grip strength and SMI as covariates, and the analysis was controlled for gender and weight. The results indicated that low SPPBm was associated with grip strength (OR: 0.88, 95% CI: 0.84–0.92), independent of SMI, gender and weight. The results were similar with gait
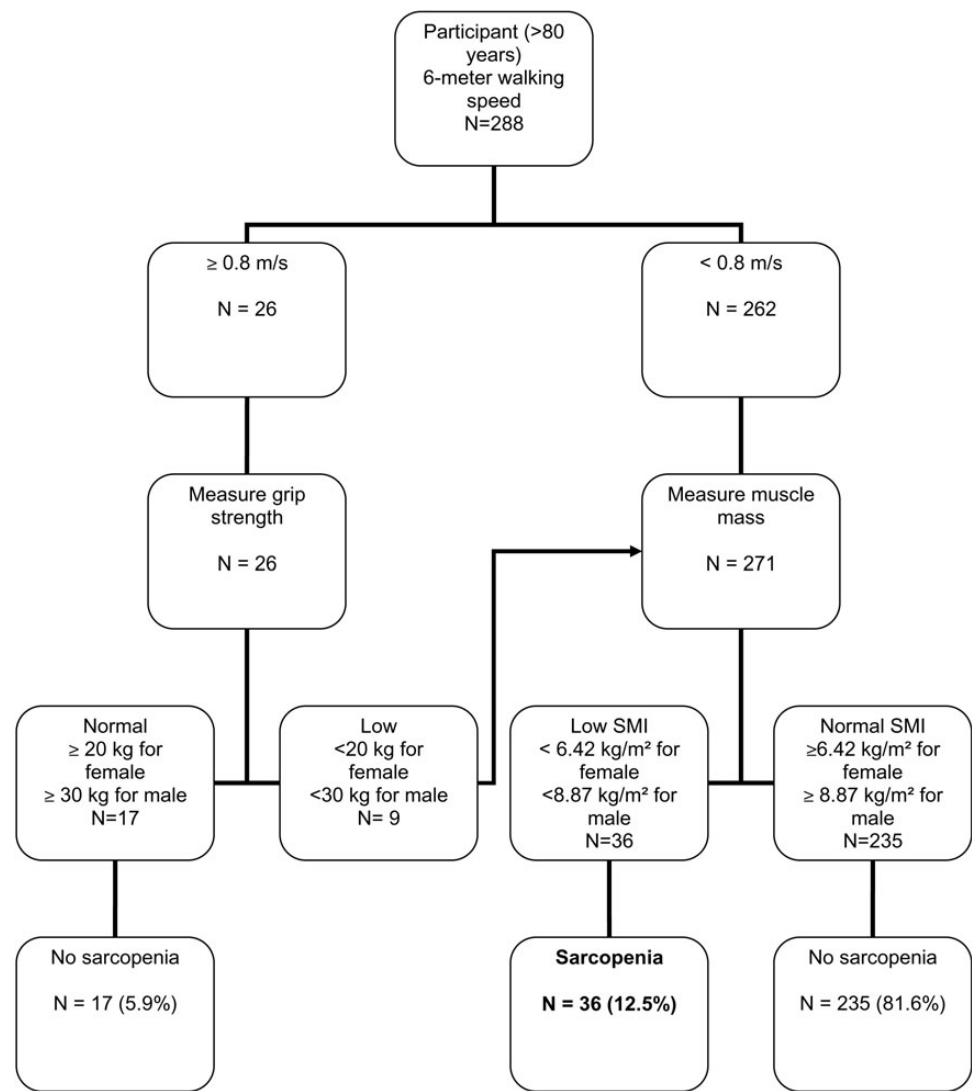
Figure 1. Sarcopenia status of Belfrail participants according to the algorithm suggested by EWGSOP.

speed as the dependent variable showing a correlation with grip strength, independent of SMI, gender and weight (Supplementary data are available in *Age and Ageing* online, Appendix Table S2).

Discussion

Our results showed that 12.5% (*n* = 36) of the participants in the study were regarded as sarcopenic, according to the EWGSOP algorithm [13]. These results are consistent with the prevalence values observed in the Rancho Bernardo study, which was conducted among community-dwelling individuals aged 80 years and older [24], as well as the European Epidos study, which detected a prevalence of 10.9% in the 86-to-95-year-old age group [2]. However, other reported prevalence values for sarcopenia have varied widely (range 11–50%) between several cohorts of older individuals [25]. Bijlsma *et al.* found that the prevalence of sarcopenia was highly dependent on the criteria used to define the condition [15]. This finding was confirmed in our study, as there was a strong discrepancy between the prevalence of low muscle mass and the prevalence of low grip strength or poor SPPBm score; the prevalence of sarcopenia according to single criteria was estimated for men and woman, respectively, to be 14.6 and 12.4% according to SMI, 49.5 and 59.5% according to grip strength criterion, 44.7 and 70.8% according to SPPBm and 81.6 and 96.2% according to gait speed.

Reports on the prevalence of sarcopenia and studies that establish commonly used cut-off values are very often based on values obtained from individuals aged <60–65 years [13, 23], although important physiological differences affecting muscle function occur between the ages of 60 and 80 years [6, 7, 26]. McNeil *et al.* found that despite the loss of 50% of motor neurons between 60 and 80 years, the clinical relevance of the decline in muscle strength becomes mainly important after 80 years [6]. Indeed, several studies have shown that muscle strength declines more rapidly than muscle mass among very old individuals and that the loss of strength cannot be fully explained by the decrease in muscle mass

Table 1. Characteristics of the Belfrail study participants according to their sarcopenia status determined by the EWGSOP algorithm

	All (n = 288)	No sarcopenia (n = 252)	Sarcopenia (n = 36)	P-value
Age	84.8 ± 3.6	84.7 ± 3.6	85.7 ± 4.4	P = 0.14
Gender				
Female	185 (64.2%)	162 (64.3%)	23 (63.9%)	P = 0.96
Male	103 (35.8%)	90 (35.7%)	13 (36.1%)	
Weight	68.5 ± 12.7	70.0 ± 11.9	58.3 ± 13.6	P < 0.001
BMI	27.2 ± 4.5	27.8 ± 4.2	23.0 ± 4.1	P < 0.001
Living at home (%)				
Alone	109 (37.8)	100 (39.7)	9 (25.0)	P = 0.39
With someone	158 (54.9)	134 (53.2)	24 (65.7)	
Institutionalised	21 (7.3)	18 (7.1)	3 (8.3)	
Care at home (n = 267)	(n = 267)	(n = 234)	(n = 33)	P = 0.36
No	225 (84.3%)	199 (85.0%)	26 (78.8%)	P = 0.22
Yes	42 (15.7%)	35 (15.0%)	7 (21.2%)	
Level of education (n = 286)	(n = 286) (%)	(n = 252) (%)	(n = 34) (%)	
Without qualification/primary school	101 (35.3)	92 (36.5)	9 (26.5)	
Secondary education	156 (54.5)	137 (54.4)	19 (55.9)	
College/University	29 (10.1)	23 (9.1)	6 (17.6)	
Number of disease	4.4 ± 2.4	4.4 ± 2.5	4.4 ± 2.0	P = 0.94
SPPB	(n = 288)	(n = 252)	(n = 36)	P = 0.19
	7.0 (3.0–10.0)	7.0 (3.0–10.0)	5.0 (2.0–9.0)	
SPPB cut-off (%)				
SPPB >8	111 (38.8)	100 (39.8)	11 (31.4)	P = 0.29
SPPB ≤8	175 (61.2)	151 (60.2)	24 (68.6)	
ADL	25.0 (21.0–27.0)	26.0 (22.0–27.0)	23.0 (20.0–26.8)	P = 0.90
LAPAQ total score	82.5 (48.3–110.0)	85.0 (56.0–112.0)	61.5 (13.5–88.0)	P = 0.001
LAPAQ quartile (%)				
1 (lowest)	73 (25.3)	57 (22.6)	16 (44.4)	P = 0.02
2	71 (24.7)	61 (24.2)	10 (27.8)	
3	72 (25.0)	66 (26.2)	6 (16.7)	
4 (highest)	72 (25.0)	68 (27.0)	4 (11.1)	
GDS-15 (n = 287)	(n = 287)	(n = 251)	(n = 36)	
	2.0 (1.0–3.0)	2.0 (1.0–3.0)	2.5 (1.3–4.8)	P = 0.12
	(n = 288)	(n = 252)	(n = 36)	
MMSE	28.0 (26.0–29.0)	28.0 (26.0–29.0)	27.0 (24.0–29.0)	P = 0.049
MMSE score 25–30	238 (82.6%)	212 (84.1%)	26 (72.2%)	P = 0.12
MMSE score 21–24	34 (11.8%)	26 (10.3%)	8 (22.2%)	
MMSE score <20	16 (5.5%)	14 (5.6%)	2 (5.6%)	
Grip strength maximum	22.9 ± 9.1	23.4 ± 9.1	19.3 ± 9.0	P = 0.01
Grip strength cut-off (%)				
<20/30[a]	161 (55.9)	134 (53.2)	27 (75.0)	P = 0.014
>20/30[a]	127 (44.1)	118 (46.8)	9 (25.0)	
Speed	0.5 ± 0.2	0.5 ± 0.2	0.5 ± 0.2	P = 0.38
Speed cut-off				
<0.8 m/s	262 (91.0)	229 (90.9)	33 (91.7)	P = 0.88
≥0.8 m/s	26 (9.0)	23 (9.1)	3 (8.8)	
SMI	8.5 ± 1.8	8.7 ± 2.8	6.7 ± 1.3	P < 0.001
SMI cut-off (%)				
SMI <6.42/8.87[b]	38 (13.2)	2 (0.8)	36	P < 0.001
SMI >6.42/8.87[b]	250 (86.8)	250 (99.2)	0	

Data are given as numbers (percentages) for the following variables: gender, living at home, care at home, level of education, SPPB cut-off, LAPAQ quartile, MMSE, grip strength cut-off, speed cut-off, and SMI cut-off; Continuous variables are reported as medians ±25–75 percentiles for SPPB, ADL, LAPAQ, GDS-15 and MMSE; for all other Continuous variables, the means ± SD are reported.

BMI, body mass index; SPPB, short physical performance battery; ADL, activity of daily living; LAPAQ, LASA Physical Activity Questionnaire; GDS, Geriatric Depression Scale; MMSE, Mini-Mental State Examination; SMI, skeletal muscle index.

[a]Grip strength <20 kg for women and <30 kg for men.
[b]SMI <6.42 kg/m² for women and 8.87 kg/m² for men.

alone [5, 6]. Furthermore, it has been suggested that in subjects aged 80 years and older, muscle strength and physical performance capacity may be more relevant indicators of sarcopenia than the muscle mass index [4–7, 14].

In the current study, grip strength and the SPPBm score or gait speed were not related to the SMI. Despite demonstrating a sufficient SMI value, a large number of participants showed low muscle strength and/or poor SPPBm score or

Table 2. Proportions of participants arranged by SMI cut-off, grip strength cut-off, SPPB cut-off and gait speed cut-off

	Grip strength	
	<20 (women)/30 (men) (%)	>20 (women)/30 (men) (%)
SMI >6.42 (women)/8.87 (men) (*n* = 250)		
SPPB ≤8	97 (38.8)	51 (20.4)
SPPB >8	37 (14.8)	65 (26.0)
SMI <6.42 (women)/8.87 (men) (*n* = 38)		
SPPB ≤8	20 (52.6)	5 (13.2)
SPPB >8	7 (18.4)	6 (15.8)
SMI >6.42 (women)/8.87 (men) (*n* = 250)		
Gait speed ≤0.8	128 (51.2)	101 (40.4)
Gait speed >0.8	6 (2.4)	15 (6.0)
SMI <6.42 (women)/8.87 (men) (*n* = 38)		
Gait speed ≤0.8	24 (63.1)	9 (23.7)
Gait speed >0.8	3 (7.9)	2 (5.3)

Data are given as numbers (percentages).
For SPPB, among the participants with SMI values above the cut-off, 38.8% (*n* = 97) had both a grip strength and SPPB level below the cut-off, 14.8% had grip strength values below the cut-off, and 20.4% had a SPPB level below the cut-off. For gait speed, among the participants with SMI values above the cut-off, 51.2% (*n* = 128) had both a grip strength and gait speed level below the cut-off, 2.4% had grip strength values below the cut-off, and 40.4% had a gait speed level below the cut-off.
SPPB, short physical performance battery; SMI, skeletal muscle index.

gait speed, which places them at risk for disability or mortality [12, 27]. In our study, the multivariate analysis found that the SPPBm score and gait speed were associated with grip strength score but not with the SMI nor with weight. This finding may also be explained by changes in the participants' muscle quality, as the number of type II fast-contracting fibres decreases with age [28].

Thus, the question arises as to whether a different approach for defining sarcopenia among the very old is needed. The current guidelines rightly seek to combine quantitative and qualitative aspects of sarcopenia. However, this study showed that the EWGSOP algorithm does not provide much additional value to determine the prevalence of sarcopenia compared with the use of a single measurement of SMI. Furthermore, using these guidelines subjects with low muscle strength and/or poor physical performance without any loss in muscle mass cannot be set equal to those with normal muscle strength and physical performance, given their increased risk. Moreover, a potential problem lies with the cut-off values used for muscle strength and physical performance, and it is possible that age-related cut-off values should be used.

Strengths and limitations

The fact that the participants in the current study were included by their GP allowed us to create a heterogeneous population representative of the very old living in Belgium, as >90% of people aged 80 years and older in Belgium regularly see their GP [16]. Furthermore, the current study was the first to compare the prevalence of sarcopenia using multiple criteria among the same cohort of subjects aged 80 years and older.

A few limitations of the current study should be considered. First, BIA was available for only half of the participants, as BIA only became available 6 months after the start of the study. However, once the equipment became available, all patients were included, so no inclusion bias was present. Secondly, the SPPBm test used in this study was slightly different from the standard SPPB test [21]. Therefore, individual scores on the balance task could possibly be underestimated. And although the EWGSOP algorithm does not specify which walking test to use, the high percentage of low gait speed could possibly be explained by the walking test used in this study (3-m walk, turn, 3-m walk) when compared with the standard test where participants walk 4 or 6 m without turning around.

Conclusion

In a representative population-based sample of subjects aged 80 years or older the prevalence of sarcopenia according to the EWGSOP algorithm was similar to the prevalence of sarcopenia with SMI as a single criterion. Furthermore, a large number of participants with a sufficient SMI value showed low muscle strength and/or a poor SPPBm score. Moreover, a low SPPBm was associated with grip strength but not with SMI. These results suggest that additional research is needed to validate the proposed EWGSOP algorithm for individuals aged 80 years and older.

Key points

- The prevalence of sarcopenia using the EWGSOP algorithm or muscle mass as a single criterion is similar in Belfrail population.
- Despite the presence of sufficient muscle mass a large number of participants showed low grip strength and/or a poor SPPBm score.
- Low physical performance is associated with grip strength independent of muscle mass, gender and weight.

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Conflicts of interest

None declared.

Supplementary data

Supplementary data mentioned in the text is available to subscribers in *Age and Ageing* online.

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Association of physical activity with sarcopenia and sarcopenic obesity in community-dwelling older adults: the Fourth Korea National Health and Nutrition Examination Survey

Mikyung Ryu[1], Jaeseong Jo[2], Yunhwan Lee[1,3], Yoon-Sok Chung[4], Kwang-Min Kim[5], Weon-Chil Baek[6]

[1]Department of Preventive Medicine and Public Health, Ajou University School of Medicine, 164 World cup-ro, Youngtong-gu, Suwon 443-721, Republic of Korea
[2]Department of Public Health and Institute for Health Promotion, Graduate School of Yonsei University, Seoul, Republic of Korea
[3]Institute on Aging, Ajou University Medical Center, 164 World cup-ro, Youngtong-gu, Suwon 443-721, Republic of Korea
[4]Department of Endocrinology and Metabolism, Ajou University School of Medicine, Suwon, Republic of Korea
[5]Department of Family Practice and Community Health, Ajou University School of Medicine, Suwon, Republic of Korea
[6]Institute for Sport-Health Science Research, Kyonggi University, Suwon, Republic of Korea

Address correspondence to: Y. Lee. Tel: +82-31-219-5085; Fax: +82-31-219-5084. Email: yhlee@ajou.ac.kr

Abstract

Objective: this study examined the association of physical activity with sarcopenia and sarcopenic obesity among the community-dwelling Korean elderly.

Methods: subjects consisted of 2,264 aged 65 years or older in the 2008–09 Korea National Health and Nutrition Examination Survey. Sarcopenia was defined as 2 SD below the mean of the appendicular skeletal muscle/weight for healthy young adults. Obesity was defined as waist circumference ≥90 cm for men and ≥85 cm for women. Levels of physical activity were classified using the metabolic equivalent task method.

Results: the prevalence of sarcopenia was 12.1% in men and 11.9% in women. Among those with sarcopenia, obesity was prevalent in 68.3% of men and 65.0% of women. Adjusting for all covariates, compared with those with low physical activity, men who engaged in moderate and high activity were 38% and 74%, respectively, less likely to have sarcopenia (P_{trend} < 0.001). In women, the relationship between physical activity and sarcopenia was not significant. For sarcopenic obesity, men participating in moderate [odds ratio (OR) = 0.47; 95% confidence interval (CI) 0.26–0.87] and high (OR = 0.27; 95% CI: 0.12–0.60) physical activity, compared with low activity, had significantly lower risk (P_{trend} = 0.001). In women, high physical activity was associated with a lower risk of sarcopenic obesity (OR = 0.43; 95% CI: 0.22–0.86).

Conclusion: physical activity is associated with a reduced risk of sarcopenia and sarcopenic obesity in older Korean adults. There were gender differences in the relationship, with stronger associations observed in men than in women.