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# Sarcopenia in community-dwelling persons over 60 years of age from a northern Spanish city: relationship between diagnostic criteria and association with the functional performance

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## Abstract

**Introduction:** Sarcopenia is a recognized problem in older people. Currently, its diagnosis goes beyond a simple loss of muscle mass. The aim of this study was to determine the frequency of sarcopenia, defined by the European Working Group on Sarcopenia in Older People (EWG-SOP), in independent persons over 60 years of age from a northern Spanish city. In addition, this study compared the diagnostic criteria for sarcopenia and assessed the differences in functional performance according to them.

**Methods:** A cross-sectional study was carried out on 258 members of community centers of both genders. Body composition was assessed with dual-energy X-ray absorptiometry. Appendicular lean mass index (App LMI), hand grip strength (HGS), and 8 foot up-and-go test (8f-UG) were used to diagnose sarcopenia.

**Results:** The frequency of sarcopenia was 2.4% (n=6). In women, the App LMI was correlated with HGS (r= 0.164, p<0.05) and 8f-UG (r= -0.167, p<0.05), while in men, the App LMI was correlated with HGS (r=0.241, p<0.05) but not with 8f-UG (r= -0.173, p=0.117). The subjects with low HGS and low performance in the 8f-UG presented lower values in other functional outcomes than people with low App LMI (p<0.05).

**Conclusions:** Using the EWG-SOP definition, the frequency of sarcopenia was low in a group of individuals over 60 years of age from a northern Spanish city. In clinical practice, greater emphasis should be placed on the decrease in muscle strength and functional performance rather than on low muscle mass alone.

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## SARCOPENIA EN PERSONAS MAYORES DE 60 AÑOS RESIDENTES EN LA COMUNIDAD DE UNA CIUDAD DEL NORTE DE ESPAÑA: RELACIÓN ENTRE SUS CRITERIOS DIAGNÓSTICOS Y ASOCIACIÓN CON EL RENDIMIENTO FUNCIONAL

## Resumen

**Introducción:** La sarcopenia es un problema reconocido en la personas mayores. Actualmente, su diagnóstico va más allá de una simple pérdida de la masa muscular. El objetivo de este estudio fue determinar la frecuencia de sarcopenia definida por el European Working Group on Sarcopenia in Older People (EWG-SOP), en personas mayores de 60 años con vida independiente de una ciudad del norte de España. Además, el estudio comparó los criterios diagnósticos para sarcopenia y evaluó las diferencias en el rendimiento funcional de acuerdo a ellos.

**Métodos:** Se realizó un estudio transversal con 258 personas de ambos géneros, pertenecientes a centros comunitarios. La composición corporal se evaluó con absorciometría dual por rayos-X. El índice de masa magra apendicular (IMMA), la fuerza de prensión manual (FPM) y el 8 foot up-and-go test (8f-UG) fueron empleados para el diagnóstico de sarcopenia.

**Resultados:** La frecuencia de sarcopenia fue de 2.4% (n=6). En las mujeres, el IMMA se correlacionó con el FPM (r= 0.164, p<0.05) y 8f-UG (r= -0.167, p<0.05); mientras en los hombres, el IMMA correlacionó con FPM (r=0.241, p<0.05) pero no con el 8f-UG (r= -0.173, p=0.117). Los participantes con baja FPM y bajo rendimiento funcional en el 8f-UG presentaron valores más bajos en otros resultados funcionales que las personas con un bajo IMMA (p<0.05).

**Conclusiones:** al emplear la definición del EWG-SOP, la frecuencia de sarcopenia fue baja en un grupo de personas mayores de 60 años de una ciudad del norte de España. En la práctica clínica, debe hacerse más énfasis en la disminución de la fuerza muscular y el rendimiento funcional, que en la baja masa muscular únicamente.

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Palabras clave: *Sarcopenia. Músculo esquelético. Fuerza muscular. Aptitud física. España.*

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## Abbreviations

EWGSOP: European Working Group on Sarcopenia in Older People.

DXA: Dual energy X-ray absorptiometry.

BIA: Bioelectrical Impedance Analysis.

ALM: Appendicular lean mass.

App LMI: Appendicular lean mass index.

8f-UG: 8 foot up-and-go.

HGS: Isometric hand grip strength.

MVIS-Q: Maximum voluntary isometric strength of quadriceps.

TUG: Time up go test.

## Introduction

Sarcopenia was originally defined by Rosenberg in 1989 as the decrease in muscle mass associated with aging<sup>1</sup>. Several factors, such as: neuromuscular, endocrine, nutritional, genetic, and a sedentary life style, contribute to its development<sup>2</sup>. It has been associated with an increased risk of disability, dependency, hospitalization and mortality in older people<sup>2,3</sup>. In addition, there is a high economic burden on health facilities (\$ 18.5 billion in the United States in 2000) with respect to the treatment of sarcopenia<sup>4</sup>.

In 2010, the European Working Group on Sarcopenia in Older People (EWGSOP) published a new definition that considers sarcopenia not only as the loss of mass, but also as a decrease in muscle strength or functional performance<sup>5</sup>. The argument is that defining sarcopenia in terms of muscle mass alone is an insufficient concept and has limited clinical value<sup>5</sup>. The prevalence of sarcopenia in some studies that have used the EWGSOP definition has ranged from 0.9% to 33.6%, varying according to place of residence, age, body composition, functional capacity level and other co-morbidities (cerebrovascular disease, osteoarthritis and osteoporosis)<sup>6-12</sup>.

Moreover, there is a wide variety of measurement instruments to assess the diagnostic components of sarcopenia, which vary according to their costs and accuracy and that could also be related to the different results of previous studies<sup>5, 13, 14</sup>. In addition, the relationships among the diagnostic components of sarcopenia defined by EWGSOP have not been sufficiently revised.

The aim of this study was to determine the frequency of sarcopenia in community-dwelling persons over 60 years of age from a northern Spanish city using the EWGSOP definition. In addition, the purpose was to compare the diagnostic criteria for sarcopenia and assess the differences in functional performance according to them.

## Methods

### Subjects

We conducted a cross-sectional study involving older people attending academic and recreational programs from three community centers in the city of Leon, Spain (n= 3657). All subjects were invited to participate in the study between November 2012 and March 2013 during informative meetings. The inclusion criteria were: participants over 60 years of age, residing in Leon, and living independently. Exclusion criteria were: cognitive impairment, heart failure (grades II-IV), ischemic heart disease, and uncontrolled musculoskeletal problems that would prevent the completion of the tests. Around 600 older people attended the informative meetings and 266 of them decided to participate voluntarily in the study. Finally, 258 subjects were included in the study group after applying the eligibility criteria. The subjects excluded and the reasons were: one was under 60, four did not attend the evaluations and three had severe musculoskeletal problems. Ethical approval was obtained from the Ethics Committee of the University of Leon and the study respected the principles of the Declaration of Helsinki. All participants gave their written informed consent.

### Measurements

Body composition was assessed by dual energy X-ray absorptiometry (DXA) (Lunar Prodigy-GE, Software Encore 2009® version 12.1). Total mass, fat mass, total lean mass, arms lean mass, legs lean mass, and appendicular lean mass (ALM) measured in kilograms were obtained for each participant. Height was measured once by using a *Body meter* (SECA Model 208), which has an accuracy of up to 0.05 centimeters.

Functional performance was assessed according to four tests taken from the Senior Fitness Test –Arm curl, Chair stand, Step-in-place, 8 foot up-and-go (8f-UG), which have been validated for the evaluation of functional fitness in older adults<sup>15, 16</sup>. Isometric hand grip strength (HGS) of both the dominant and the non-dominant side were performed with each subject sitting, the shoulder at 90° and the elbow in full extension using a Jamar dynamometer (Promedics, Blackburn, UK). Two trials for each hand were performed and the highest value of the strongest hand was used in the analyses.

Maximum voluntary isometric strength of quadriceps (MVIS-Q) was measured for both legs using a load cell (Globus Ergo System, software IsoMetric 20.40 Test, Italy) in a leg extension machine (BH Fitness Nevada Pro-T, Spain). On command, the subject performed an isometric quadriceps extension (as fast as possible) at 90° of knee flexion during five seconds. Two trials were performed; the highest result of the quadriceps strength was used (in Newton= N).

**Table I**  
*Characteristics of participants according to gender and age in tertiles (n=258)*

	Women (n=175)			Men (n=83)		
	Lowest tertile	Middle tertile	Highest tertile	Lowest tertile	Middle tertile	Highest tertile
n	57	59	59	28	27	28
Age (years)	65.1 (1.8)	70.3 (1.6)	77.4 (3.1)	66.0 (2.5)	70.9 (1.0)	77.5 (2.9)
Height (cm)	155.0 (4.8)	153.1 (5.8)	152.2 (5.6)	166.7 (5.9)	166.2 (6.8)	165.9 (7.7)
Weight (kg)	67.3 (13.5)	64.1 (15.6)	63.1 (9.2)	75.9 (16.3)	77.6 (9.9)	76.0 (11.4)
BMI (kg/m <sup>2</sup> )	28.0 (3.9)	27.4 (4.3)	27.2 (3.8)	27.3 (3.2)	28.0 (2.3)	27.5 (3.3)
Body composition						
Fat mass (kg)	26.9 (7.6)	25.0 (7.5)	24.2 (7.2)	20.8 (6.5)	22.3 (6.5)	20.7 (6.9)
Body fat %	39.3 (6.4)	38.2 (6.2)	37.6 (6.8)	26.9 (5.9)	28.3 (5.6)	26.7 (5.4)
Total lean mass (kg)	38.2 (4.7)	37.1 (3.6)	36.8 (3.4)	52.3 (5.2)	52.4 (5.3)	52.4 (5.7)
Lean mass arms (kg)	4.1 (.7)	3.9 (.6)	3.8 (.5)	6.1 (.7)	6.2 (.7)	5.9 (.8)
Lean mass legs (kg)	12.0 (1.6)	11.4 (1.3)	11.4 (1.4)	16.3 (1.8)	16.4 (1.9)	16.3 (2.1)
ALM (kg)	16.1 (2.2)	15.4 (1.7)	15.3 (1.8)	22.4 (2.4)	22.6 (2.5)	22.2 (2.8)
App LMI (kg/m <sup>2</sup> )	6.7 (.8)	6.6 (.6)	6.6 (.6)	8.1 (.7)	8.2 (.7)	8.1 (.8)
Functional performance						
Arm curl test (rep)	19.1 (3.5)	18.8 (3.4)	18.3 (4.3)	18.3 (3.5)	17.2 (2.4)	16.2 (3.9)*
Chair stand test (rep)	18.7 (3.8)	17.9 (3.5)	16.7 (3.3)*	17.4 (3.7)	17.7 (4.8)	15.6 (3.4)
Step-in-place (steps)	112.9 (16.4)	108.3 (16.4)	100.7 (17.3)* <sup>†</sup>	115.1 (18.4)	109.9 (18.4)	108.0 (27.4)
8f-UG (s)	4.8 (.7)	5.0 (1.6)	5.4 (.9)*	4.5 (.6)	4.6 (.5)	5.6 (1.4)* <sup>†</sup>
Muscle strength						
HGS (kg)	24.9 (5.1)	23.9 (4.8)	22.2 (3.6)*	41.1 (7.5)	40.0 (5.2)	35.1 (7.7)* <sup>†</sup>
MVIS-Q (N)	638.9 (133.5)	625.3 (156.8)	547.7 (144.1)* <sup>†</sup>	960.4 (197.7)	903.2 (236.9)	818.9 (217.1)*

Data means and SD. ALM, appendicular lean mass; App LMI, appendicular lean mass index (ALM/height<sup>2</sup>); 8f-UG, 8 foot up-and-go test; HGS, hand grip strength; MVIS-Q, maximum voluntary isometric strength of quadriceps. Differences between age groups (One-way ANOVA with Tukey post hoc analysis; p<0.05): \*significant difference between highest and lowest tertile, <sup>†</sup> significant difference between highest and middle tertile.

Sarcopenia was defined using the EWGSOP definition in which a person is categorized as having sarcopenia, whether they have low muscle mass plus low muscle strength or low functional performance<sup>5</sup>. Low muscle mass was defined according to appendicular lean mass index (App LMI) (ALM/h<sup>2</sup>), defining a threshold of 7.26 kg/m<sup>2</sup> for men and 5.5 kg/m<sup>2</sup> for women<sup>17</sup>. Low muscle strength was defined as HGS <20 kg in women and <30 kg in men<sup>18</sup>. Finally, low functional performance was defined according to the execution time in the 8f-UG, using the cutoff points presented by age and gender in the Rikli & Jones study<sup>15</sup>: women (60-64 y >5s; 65-69 y >5.3s; 70-74 y >5.6s; 75-79 y >6.0s; 80-84 y >6.5s; 85-89 y >7.1s); men (60-64 y >4.8s; 65-69 y >5.1s; 70-74 y >5.5s; 75-79 y >5.9s; 80-84 y >6.4s; 85-89 y >7.1s). Although

the gait speed and the Short Physical Performance Battery are tests mainly suggested by the EWGSOP to evaluate functional performance, this consensus also recognizes other tests, such as the time up go test (TUG)<sup>5</sup>, that may be useful to assess functionality. Therefore, we selected the 8f-UG (the short version of the TUG), since it is a test with good reliability in its application (test – retest: men 0.98, IC95% 0.96-0.99; women 0.90, IC95% 0.83-0.95)<sup>19</sup>. Also, the 8f-UG has age- and gender- normalized values in the Spanish context<sup>20</sup> and a good inverse correlation with performance measurements for daily activities (r= -0.363; p<0.01)<sup>21</sup>. On the other hand, the 8f – UG is considered a good tool to discriminate persons with the risk of falling; a value of 8.5 seconds or more in the execution of the test shows the people with this risk<sup>22</sup>.

Mean and standard deviations (SD) were used as descriptive statistics for body composition, muscle strength, and physical performance according to gender and age divided in tertiles. One-way ANOVA with Tukey post-hoc analysis was used to determine differences among age groups. Absolute and relative frequencies were calculated for sarcopenia according to gender. Pearson's correlation coefficient was used to describe the relationship between the diagnostic criteria for sarcopenia. Independent samples t tests were calculated to determine differences in functional performance between those with a low value within the parameters evaluated for the diagnosis of sarcopenia and the remaining participants. A  $p < 0.05$  was considered to be statistically significant. All analyses were performed using the SPSS 19.0 package (SPSS, Chicago, IL).

## Results

Of the 258 subjects, 68.2% were women; the age was 70.9 years (SD 5.5) in men and 71.5 years (SD 5.2) in women. Summary characteristics of the subjects are presented in table I according to gender and age in tertiles. There were no significant differences in any of the muscle mass variables by age in both women and men. On the contrary, in the HGS, MVIS-Q and physical performance tests (except for the Arm curl test), the lowest values were found in the oldest women ( $p < 0.05$ ); the same result was observed in men in the Arm curl, Chair stand, 8f-UG, HGS and MVIS-Q ( $p < 0.05$ ). The frequency of sarcopenia defined by the EWGSOP was 2.4% ( $n=6$ ); it was more frequent in men than in women, with 4.9% and 1.2% respectively.

In women, the App LMI was correlated with HGS ( $r=0.164$ ,  $p < 0.05$ ) and 8f-UG ( $r = -0.167$ ,  $p < 0.05$ ), while the HGS and 8f-UG presented an inverse correlation ( $r = -0.270$ ,  $p < 0.01$ ). In men, the App LMI was correlated with HGS ( $r=0.241$ ,  $p < 0.05$ ) but not with 8f-UG ( $r = -0.173$ ,  $p=0.117$ ), while the HGS and 8f-UG presented an inverse correlation ( $r = -0.365$ ,  $p < 0.01$ ).

The differences in functional performance according to the parameters evaluated for the diagnosis of sarcopenia are presented in table II. The people with low App LMI (5.4%) presented no significant differences in their functional performance and the MVIS-Q regarding subjects with normal App LMI. However, the subjects with low HGS (13.2%) presented lower values in the Arm curl test, Step-in-place and MVIS-Q than normal HGS subjects ( $p < 0.05$ ). Finally, the people with low performance in the 8f-UG (13.6%) presented lower values in all other functional tests and MVIS-Q than subjects with normal performance in the 8f-UG ( $p < 0.05$ ).

## Discussion

To our knowledge, this is one of the first studies on sarcopenia in community-dwelling persons over 60 years of age from a northern Spanish city using the EWGSOP definition. Among the 258 men and women, the frequency of sarcopenia was 2.4%. This was higher than that found in a study with Finnish women, aged 70–80 (0.9%) and lower than in other studies (between 3.7% and 6.8%), which also applied the EWGSOP definition and evaluated the muscle mass with DXA<sup>9, 10, 12, 23</sup>. On the other hand, other studies, in which the muscle mass was evaluated through bioelectrical impedance analysis (BIA) or circumferences, reported much higher prevalences (between 10.8% and 32.8%)<sup>6, 11, 24–26</sup>. Although there are differences in the characteristics of the populations of previous studies, which may be related to the variability of the prevalences found, the technique to measure muscle mass may be an important factor explaining this variability. Safer et al. state as inappropriate measuring muscle mass in older people using circumferences because of modifications in the elasticity of the skin resulting from changes in the fat deposits due to aging<sup>27</sup>. Moreover, the DXA is considered to be more reliable and accurate for the muscle mass diagnosis than the anthropometric and BIA measurements<sup>2</sup>. Future research could evaluate the effect of the evaluation technique of muscle mass on the diagnosis of sarcopenia as defined by EWGSOP.

In general, sarcopenia was uncommon in the study group. This could also be explained by the possible involvement of the technique of measuring muscle mass because the participants were active and independent usually due to their participation in recreation programs and academic training, which may be related to a lower risk of sarcopenia. The study by Cherin et al. with ambulatory participants ( $n = 1,445$ ) aged 45 years and older found that the probability of sarcopenia was lower among subjects involved in leisure physical activities for three hours or more per week (OR 0.45; 95 % CI 0.24–0.93)<sup>28</sup>. On the other hand, the App LMI, which is the first criterion to comply within the EWGSOP definition, reported no significant differences among the age groups in both genders, contrary to HGS and 8f-UG. This suggests that a possible deterioration of the health of the people studied with increasing age, which leads to greater dependency or disability, may be related more to the loss of muscle strength and functional performance than muscle mass.

In this study, the correlations between the diagnostic criteria for sarcopenia were low between the App LMI and HGS in both genders (women  $r=0.164$ , men  $r=0.241$ ;  $p < 0.05$ ). Compared to the study by Barbat- Artigas et al., the correlation between these variables was also low and not significant among women ( $r=0.14$ ,  $p=0.35$ ), while men presented a higher correlation ( $r=0.43$ ,  $p < 0.05$ )<sup>29</sup>. This could be explained because other factors exist that more widely predict

**Table II**  
Differences within measured variables according to parameters used for the diagnosis of sarcopenia

	App LMI (kg/m <sup>2</sup> )		HGS (kg)		8f-UG (s)	
	Normal	Low	Normal	Low	Normal	Low
n (%)	244 (94.6)	14 (5.4)	224 (86.8)	34 (13.2)	223 (86.4)	35 (13.6)
Age (years)	71.1 (5.3)	72.6 (7.2)	70.8 (5.3)	73.4 (6.1)*	71.0 (5.4)	72.0 (5.8)
Height (cm)	157.1 (8.3)	165.1 (6.0)*	158.4 (8.2)	151.3 (7.8)*	157.8 (8.4)	155.7 (8.2)
Weight (kg)	68.4 (11.6)	70.4 (19.7)	69.3 (11.6)	63.3 (9.3)*	68.0 (11.4)	72.3 (11.9)
Body composition						
Total lean mass (kg)	42.0 (8.3)	45.1 (7.5)	42.9 (8.2)	37.0 (6.7)*	42.3 (8.4)	41.1 (7.2)
Body fat %	35.0 (8.1)	32.0 (5.3)	34.3 (8.9)	37.9 (7.5)*	34.1 (7.9)	39.4 (7.1)*
Functional performance						
Arm curl test (rep)	18.4 (3.5)	16.6 (4.9)	18.5 (3.5)	16.8 (4.9)*	18.5 (3.4)	16.6 (4.2)*
Chair stand test (rep)	17.6 (3.6)	16.3 (4.4)	17.5 (3.4)	17.7 (5.6)	17.9 (3.5)	14.8 (3.2)*
Step-in-place (steps)	108.8 (17.6)	103.1 (24.4)	109.4 (16.7)	102.2 (24.3)*	111.1 (16.7)	91.9 (17.3)*
MVIS-Q (N)	694.9 (221.4)	711.2 (223.9)	717.8 (216.7)	550.4 (195.7)*	715.6 (222.7)	569.1 (169.5)*

Data means and SD. App LMI, appendicular lean mass index (ALM/height<sup>2</sup>); 8f-UG, 8 foot up-and-go test; HGS, hand grip strength; MVIS-Q, maximum voluntary isometric strength of quadriceps. \*differences between groups (t-student; p<0,05).

the production of force than muscle mass (in terms of quantity), such as the muscle architecture, the type of fiber, the intramuscular fat and the neuromuscular activation<sup>30</sup>. The Barbat-Artigas et al. study also evaluated the correlation between the App LMI and knee extension strength (1-repetition maximum), with significant results only for women. The authors propose that the HGS may be preferentially used in men and knee extension strength in women to detect sarcopenic individuals<sup>29</sup>. Future studies on sarcopenia employing the EWGSOP definition could analyze their behavior depending on the strength of the lower limbs, as well as different types of manifestation (isometric, concentric or muscle power), which would allow a greater understanding of the strength-muscle mass relation in the diagnosis of sarcopenia.

While the correlations between App LMI and 8f-UG were very low in both genders, with no statistical significance for men (women  $r = -0.167$ ; men  $r = -0.173$ ). Meanwhile, the correlations between HGS and 8f-UG were only slightly higher, although significant (women  $r = -0.270$ , men  $r = -0.365$ ;  $p < 0.01$ ). However, the study by Krause et al., in 33 people over 65 did not report significant correlations between the fat free mass index and the TUG, nor between the HGS and TUG in both genders, whereas between the maximal knee extensor torque and TUG a high inverse correlation was found ( $r = -0.771$ ,  $p < 0.01$ )<sup>31</sup>. These results show a poor relationship between muscle mass and the functional performance (of the lower members), while the muscle strength maintains a better relationship with the latter, which improves when the strength of the lower limbs is employed. In our study, a correlation was found

between MVIS-Q and 8f-UG  $r = -0.407$  in women and  $r = -0.397$  in men ( $p < 0.01$ ) (data not shown). Thus, although it has been reported that HGS maintains a good relationship with the MVIS-Q ( $r = 0.55$  to  $0.89$ ;  $p < 0.001$ ), and that both tests may represent a common construct of body force<sup>32</sup>, which facilitates the use of HGS in both the clinic and in research, the importance of involving the evaluation of lower limb strength in future studies on sarcopenia employing the EWGSOP definition is again highlighted.

In our study, people with low muscle mass (App LMI) did not show a lower functional performance, while those with a low muscle strength (HGS) reported lower performance in almost all the functional tests, compared to those that obtained normal values. The Patil et al. study reported similar results for both criteria<sup>10</sup>. This is important, considering that low muscle strength, also known as dynapenia, represents a greater relative risk (2.20; 95% CI: 1.5–3.1) of poor physical performance, functional limitation, or physical disability in older adults, compared to low muscle mass (1.37; 95% 0.87–2.0)<sup>33</sup>.

On the other hand, people with low functional performance (8f-UG) had lower performance in all other functional tests compared to those with normal performance ( $p < 0.05$ ); this result coincides with the study by Patil et al., in which people who had a lower walking speed ( $< 0.8$  m/s) showed lower values in other functional tests applied in this study<sup>10</sup>. This indicates that the 8f-UG, which is a modified version of the three-meter TUG designed for use in places with little space, may reflect a greater decline in performance<sup>16, 34</sup>. In turn, it has been found that this test

has the ability to predict different geriatric events similar to the gait speed<sup>35</sup>.

Our study has some limitations. First, the sample consisted of people who participated voluntarily, so the results are relevant only for the study group. Second, this was a cross-sectional study and this makes it impossible to determine the nature of the associations observed, for which further controlled prospective studies are required. And third, this study did not look for variables such as previous diseases, alcohol and nicotine consumption, physical activity, nutrition and medication, which could have expanded the explanation for the sarcopenia results found.

## Conclusion

Using the EWGSOP definition, sarcopenia was uncommon in a group of community dwelling individuals over 60 years of age from a northern Spanish city. In clinical practice, a greater emphasis should be placed on the decrease in muscle strength and functional performance rather than on low muscle mass alone. Future research could review whether the application of different techniques to measure muscle mass or that involve the assessment of the muscle strength of lower limbs have some effect on the identification of sarcopenia.

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