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Sarcopenia and functional disability in aged

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Abstract

Background: *The significance of sarcopenia in recent years is due to its relationship with functional disability (FD).* **Objective:** *To determine whether a difference exists in the proportion of sarcopenia in older adults (OA) with different status of FD.* **Methods:** *Subjects over 65 years of age without sarcopenia associated diseases were included. Overview of the study: 68 OA (24 with and 44 without FD). FD was assessed by Barthel index and clinical battery (stand-up test, grip dynamometry). Sarcopenia was assessed by Lovett-Kendall scale. Statistical analysis: X^2 and OR (95% CI).* **Results:** *Sarcopenia was higher in OA with FD (n = 16 of 24 [66.7%] vs. 3 of 44 [6.8%]). The FD was associated with sarcopenia (OR: 27.3; CI: 6-156).* **Conclusion:** *Sarcopenia is associated with functional dependence in the elderly by testing Kendall-Lovett and with various clinical and functional tools for the detection and diagnosis of FD. The proportion of sarcopenia in OA was higher in the presence of FD.* (Gac Med Mex. 2016;152:400-6)

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KEY WORDS: *Sarcopenia. Elderly. Functional Disability.*

Introduction

Functional dependence (FD) is one of the most important parameters in the prediction of comorbidity in older adults (OAs). It has been associated with increased probability of undernourishment and falls causing osteoporosis-related pathological fractures; it has also been linked to infectious processes, pulmonary thromboembolism, and stroke among others. Therefore, studying factors that can be associated with higher predisposition for FD might help not only to predict and expect a possible transition to this dependence state, but would also allow for the healthcare professional to contribute in the delay of progression towards FD in OAs.

The literature supports that one of the most important features OAs with FD have is difficulty for mobilization. And of this mobilization process, perhaps the most important is the difficulty to stand up. The capacity to stand up from a chair is vital to preserve a functional independence status. It is the task that requires the highest mechanical effort among everyday's activities and is a requirement to be able to start walking. The standing-up process requires functional and anatomic integrity of the muscle mass. Therefore, sarcopenia –understood as muscle mass and strength decrease– should have great influence on mobilization capability in OAs. Functional anatomy scholars have considered that the muscle that mostly intervenes when the individual stands up is the quadriceps[1]. The purpose of the present study was to determine whether there is a difference in the proportion of sarcopenia in OAs with different FD status through a clinimetric assessment with analytical and functional evaluations in order to

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increase the possibility of opportunely and efficaciously detecting the presence of anomalies such as muscle strength decrease.

Material and method

The study was carried out using an analytical cross-over design with patients from a primary care medical unit in the city of Colima, Mexico. Sample size calculation was made using the formula for proportions difference[2], based on a study by Topinková[3]. Sixty-eight subjects older than 60 years of age were included (24 with FD and 44 without FD); subjects with any muscle-loss-inducing disease (discopathy, patellofemoral syndrome, spine or spinal cord trauma sequel, stroke sequel, myopathy, peripheral neuropathy, spinal cord lesions, chronic obstructive pulmonary disease), as well as lower limb joints limitation, dementia, depression, Parkinson's disease, grip strength alterations (osteoarthritis, fracture sequels or any type of hand or upper limbs lesion), formal physical training and those with ambulation impairments were excluded. The study was approved by the Mexican Institute of Social Security (IMSS – *Instituto Mexicano del Seguro Social)* Local Ethics Committee and each study subject granted informed consent to be included.

FD assessment

Each study subject had the Barthel index applied to assess FD in the performance of basic activities of daily living (BADL)[4]. It was created by Dorothea W. Barthel and Florence Mahoney in 1955. It is intended to measure functional independence, self-care and mobility; approximate administration time is 5 minutes (10 minutes when self-administered by the patient). It has sensitivity and specificity of 0.87 and 0.95, respectively. It is excellent to measure BADL (bathing/showering, dressing, cleaning-up, toilet use, transferences, climbing stairs up and down, urinary and fecal continence and nutrition), and it has been widely validated, with its disadvantage being that it does not detect mild changes. Possible score is from 0 to 100, according to the FD. With this assessment, 2 OA groups were formed: with and without FD (≤ 85 or > 85 scores, respectively). Additionally, handgrip dynamometry and sitting-rising tests were applied.

Sarcopenia assessment

Lovett and Kendall test was used to detect the degree of sarcopenia in the OAs' quadriceps muscle. This test was created by Robert Lovett by the year 1917 with the purpose to analytically assess muscle strength. Later, in the decade of 1930, Kendall employed a recording method with percentages, which is based on the concept of segmental weight (resistance pattern) and on the examiner's hand resistance. This way, muscles are assessed as being more, less or equally strong than the effect of the force of gravity. To carry it out, the patient is placed in the supine decubitus position, with the knee outside the table and the legs hanging. The examiner controls by placing one hand on the anterior face of the lower third of the thigh. The patient is asked to fully stretch the leg in line with the tigh. An OA was considered to have sarcopenia with a score between 2 and 3 (muscle strength of 20 and 50%, respectively), and to be sarcopenia-free with a score between 4 and 5 (muscle strength of 80 and 100%, respectively)[5-7].

Statistical analysis

Descriptive statistics included means and standard deviation determination for quantitative variables. Qualitative variables comparison between both OA groups (with and without FD) was carried out using the chi-square test. Quantitative variables comparison between both groups was performed using Student's t-test. The degree of association between the qualitative variables and the variable of interest with the FD variable was assessed by means of the odds-ratio (OR) with a 95% confidence interval (CI). Statistical significance was established at a p-value lower than 0.05. The SPSS version 16 statistical package was used.

Results

Except for gender ($p < 0.25$), all OAs' epidemiological characteristics were different between each FD group. There were no differences when the remaining variables were compared with regard to gender.

Marital status showed association with FD; being married or cohabiting were protective factors against FD ([32 vs. 10]; $p < 0.01$; OR: 0.27 [0.08-0.86]). Being a housewife showed a certain trend towards being a risk factor for FD ([21 vs. 18]; $p < 0.03$; OR: 3.29 [95% CI: 0.98-11.46]), as well as not having any level of education ([5 vs. 12]; $p < 0.001$; OR: 0.78 [1.99-32.8]).

With regard to socioeconomic stratus (SES), belonging to a low level was found to represent a 3.03-fold higher likelihood (95% CI: 0.97-9.74) for FD ($p < 0.03$).

Table 1. Epidemiological characteristics of older adults with different functional dependence status

Parameter	Functional dependence status		OR (95% CI)	p-value
	Functional independence (n = 44)	Functional dependence (n = 24)		
Gender (m/f)	19/25	7/17	0.54 (0.16-1.76)	0.25
Occupation (at/away from home)	5/39	12/12	3.29 (0.98-11.46)	< 0.03*
Level of education (none/primary or ↑)	5/39	12/12	7.80 (1.99-32.38)	< 0.00*
Marital status (accompanied/alone)	32/12	10/14	0.27 (0.08-0.86)	< 0.01*
SES (low/intermediate or ↑)	15/29	17/9	4.70 (1.42-16.06)	< 0.003*
Sarcopenia (with/without)	3/41	16/8	27.33 (5.5-156.4)	< 0.001*

*Statistical significance.
f: female; m: male; SES: socioeconomic stratus.

OAs with FD were 27-fold more likely to have sarcopenia than those without FD (16 out of 24 [67%] vs. 3 out of 44 [7%]; p < 0.001; OR: 27.3, 95% CI: 5-156) (Table 1); in addition, the proportion of sarcopenia in OAs with FD was shown to be higher than in the group of independent subjects (Fig. 1).

On the other hand, figure 2 shows that the proportion of OAs according to gender and sarcopenia presence is higher for women (16/20 with sarcopenia) than in the group without sarcopenia (26/48). Furthermore, age showed to be directly proportional according to FD status; the older the age, the higher the proportion of OAs with FD (Fig. 3).

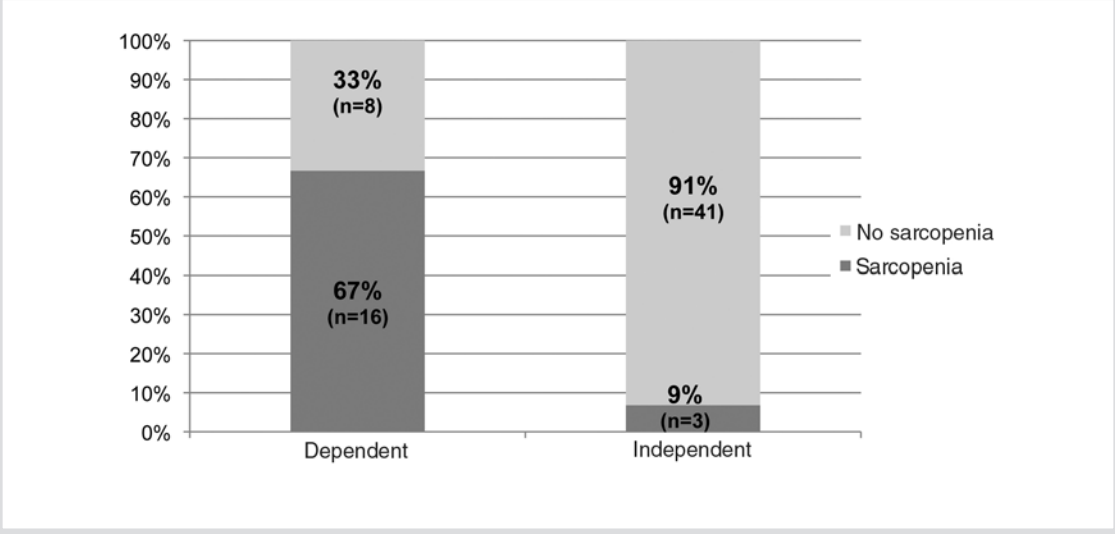

Figure 1. *Sarcopenia proportion comparison in older adults with different functional dependence status. The proportion of sarcopenia –dark grey– in older adults with functional independence is lower than in the group of dependent subjects.*

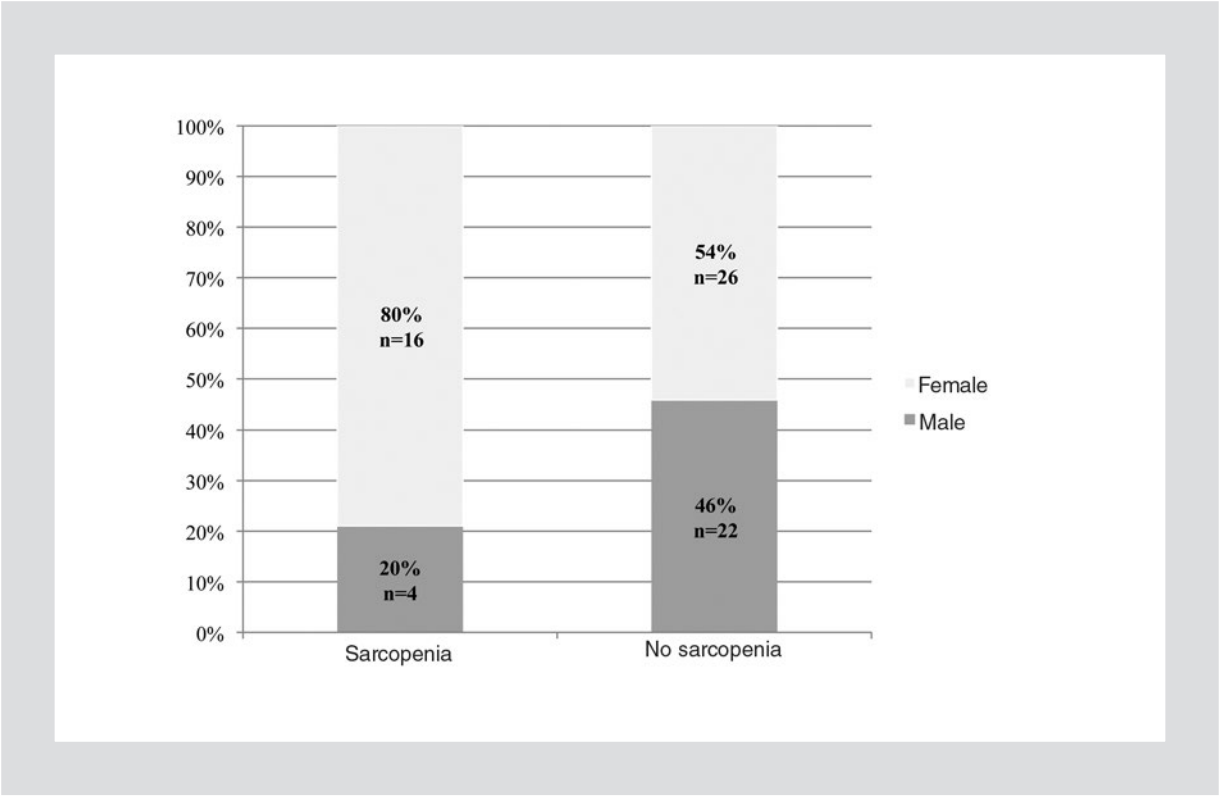

Figure 2. *Proportion of older adults according to gender and presence of sarcopenia. The proportion of older adults according to gender and presence of sarcopenia is larger in the case of women (16/20 with sarcopenia) than in the group with no sarcopenia (26/48).*

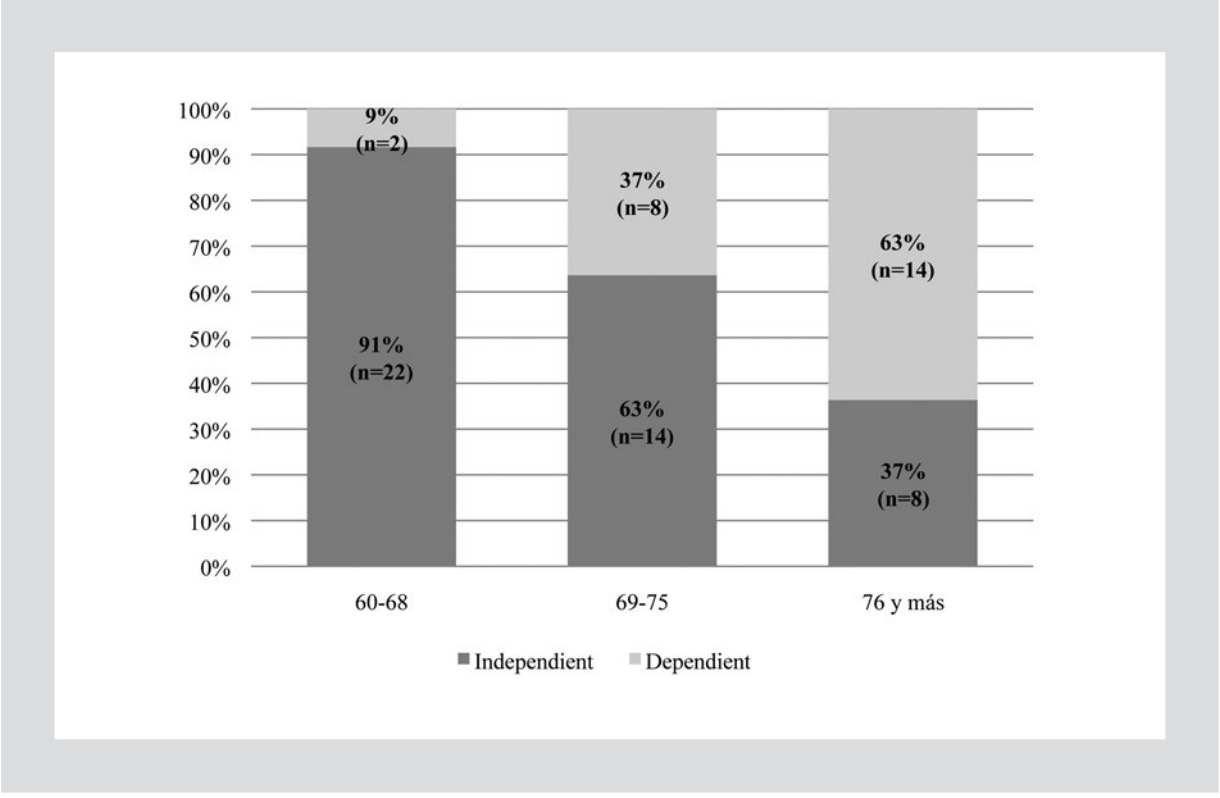

Figure 3. *Proportion of older adults according to functional status and age group. The proportion of older adults according to functional status and age group is directly proportional to the degree of functional dependence.*

Table 2. Older adults anthropometric characteristics according to functionality status

Parameter	Functional dependence status		p-value (95% CI)
	Independent (n = 44)	Dependent (n = 24)	
Weight (kg)	70.7 ± 12	65.5 ± 12	0.08* (0.77-11.1)
Height (m)	1.6 ± 0.1	1.5 ± 0.1	0.001* (0.02-0.11)
Heel/knee (cm)	48.9 ± 4	46.2 ± 4	0.01* (0.67-4.71)
Calf circumference (mm)	33.1 ± 4	33.7 ± 6	0.64* (3.22-2.02)
Brachial circumference (mm)	29.2 ± 3	28.7 ± 4	0.55* (-1.35-2.47)
Quadriceps circumference (mm)	43.9 ± 5	41.9 ± 6	0.15* (-0.81-4.79)

FD values expressed as average ± SD.
*Calculated with Student's t-test.

Table 3. Older adults functional characteristics according to functionality status

Parameter	Functional dependence status		p-value
	Independent (n = 44)	Dependent (n = 24)	
Dynamometry (kg)	28.9 ± 9	24.3 ± 8	B0.07*
Sitting-rising (s)	15.2 ± 6	19.7 ± 7	0.02*
Lovett and Kendall test (sarcopenia/no sarcopenia)	(5/39)	(15/9)	0.01‡

FD values expressed as average ± SD.
*Calculated with Student's t-test.
‡Calculated with the chi-square test.

With regard to OAs anthropometric characteristics according to FD status, height was greater in subjects with functional independence than in those with FD ([1.6 ± 0.1 vs. 1.5 ± 0.1]; $p < 0.001$), same as the heel-knee length ([48.9 ± 4 vs. 46.2 ± 4]; $p < 0.01$) (Table 2). In addition, grip dynamometry had higher values in independent than in dependent subjects, although there was no statistically significant difference ([28.9 ± 9 vs. 24.3 ± 8]; $p = 0.07$); the sitting-rising test was surmounted in less time by subjects with functional independence than by those with FD (([15.2 ± 6 vs. 19.7 ± 7]; $p < 0.02$). Finally, Lovett and Kendall test yielded scores lower than 3 points in most subjects with FD (5 vs. 15; $p < 0.001$) (Table 3).

Discussion

The results of the present study show that sarcopenia is found at higher proportions in OAs with FD. As it is well known, the fact of not having found differences between study groups with regard to the individual's gender adds up to different studies that have documented this. Some report that the risk for FD is not different between men and women when there is control for factors such as age or comorbidity[8], whereas others maintain that the risk for FD is higher in females[9]. In ours, gender was the only analyzed parameter that showed no significant difference when compared with all variables. Similarly, in the Quebec NuAge study, FD was indistinct for gender; however, males had less FD than females, as well as younger participants in comparison with the older ones[10].

In addition, the likelihood of having FD was found to be 17.7 and 12.6-fold higher when having sarcopenia (female and male gender, respectively).

Baumgartner et al., in the New Mexico Elder Health study, found that gender negatively influenced –even more in the female gender– for the development of FD in the presence of sarcopenia, with a 3.7-fold higher likelihood in men and 4.1-fold in women with regard to subjects without sarcopenia[11]. In contrast to this, our study showed no statistical difference on this parameter; however, it showed that male gender was a protective factor against FD, same as in the study by

Tseng et al., where some predictors for FD incidence in the presence of sarcopenia were analyzed, and male gender was found to be less likely to develop FD in the presence of sarcopenia[12].

Being a housewife, as well as not having any level of education was associated with FD. In the study by Howard et al., women with a body mass index (BMI) higher than 30 kg/m^2 had a protective factor against grip pressure disturbances (OR: 0.53, 95% CI: 0-37-0.76; $p < 0.001$)[13].

Additionally, in our study, SES influenced as a risk factor, since belonging to a low level represented a 3.03-fold likelihood for FD[14].

OAs anthropometric and functional characteristics have been shown to influence on FD status. In the present study, height and heel/knee length were greater in subjects with FD, and the sitting-rising test showed higher values in subjects with FD. With regard to the test of sitting on and rising from a chair, it was evaluated by Al Snih et al. and Guralnik et al.; both demonstrated that this test has clinical relevance to measure lower limb strength, since its results are consistent with upper and lower limb dynamometry, as well as with those tests measuring physical performance, such as the short battery[15,16].

In our study, parameters such as quadriceps, brachial and leg circumference showed no statistically significant difference; conversely, in the work by Choquette et al., the quadriceps circumference showed a 7-fold association with muscle strength and mobility anomalies, similarly to other parameters such as wrist circumference[17].

On the other hand, the European Consensus on Definition and Diagnosis of Sarcopenia mentioned in 2010 that in the case of sarcopenic obesity, weight changes occur on an individual basis and that there are different patterns related to age and body composition in each individual; for example, in men, these changes are attributed to an accelerated decrease in lean mass followed by an increase in fat mass, and in women, a similar pattern is observed, and intramuscular and visceral fat increase with age, while subcutaneous fat declines[18]. It is important highlighting that, probably owing to this reason, anthropometric measurements in our study such as quadriceps, brachial or leg circumferences showed no statistical differences, although, as previously mentioned, they did show a tendency to be larger in the independent subjects group.

Grip dynamometry showed no statistically significant differences in our work; however, it yielded higher values in independent that in dependent subjects. This can be attributed to the fact that the relationship of variables such as occupation was not adjusted (part of the subjects with high dynamometric figures carried out heavy tasks with their upper limbs as in the case of salt mine workers, mechanics, blacksmiths, etc.). There are studies demonstrating that parameters such as dominance, gender and age are individual factors that influence on grip strength, and other such as height, weight, size and position of the hand at the moment grip strength measurement is performed, influence on dynamometry results[19]. In the study by Arroyo et al., a close relationship of dynamometry was found with functionality and with the ability to carry out mobility activities in men and women and significant association was maintained between dynamometry and functional limitation, with increased risk for functional limitation being added in females –with older age and higher BMI– and although a good correlation was observed between grip dynamometry and lean mass, the association of grip strength with functionality was stronger than that accounted for only by muscle mass[20]. This supports evidence indicating that muscle mass decrease, high fat infiltration into muscles and decreased muscle strength are associated with mobility loss risk in OAs[21]. According to this, muscle function is shown to be more important than muscle mass volume and validates hand dynamometry as a functionality indicator. This finding is consistent with studies such as those by Newman et al., who have demonstrated that hand dynamometry provides mortality risks estimates similar to those with quadriceps strength and that this association is BMI-independent[22].

OAs with sarcopenia were 27-fold more likely to have FD than those with no FD in our study; the highest proportion corresponded to OAs without sarcopenia and without FD; the lowest proportion corresponded to OAs with sarcopenia without FD (Table 1 and Figure 1).

Lovett and Kendall scale yielded results lower than a score of 3 in most subjects with FD. Some fragility indicators such as loss of weight, gait speed, grip strength, physical activity, balance and lower limb function were shown to be FD predictors in different studies[23,24]. This supports our opinion about having clinical assessment instruments available to evaluate the quadriceps, which is the most important muscle involved in standing up; this would not only allow opportune assessment and detection, but also therapeutic interventions' success evaluation[25,26].

In view of all this, it would be of the utmost importance to continue with longitudinal studies and clinical trials further analyzing the role of sarcopenia, as well

as other factors intervening in the development of FD, in order to opportunely identify OAs that would benefit from preventive programs for this problem[27-29].

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