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Association of Fatigue With Sarcopenia and its Elements: A Secondary Analysis of SABE-Bogotá

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Abstract

Objective: Sarcopenia, fatigue, and depression are associated with higher mortality rates and adverse outcomes in the aging population. Understanding the association among clinical variables, mainly symptoms, is important for screening and appropriately managing these conditions. The aim of this article is to evaluate the association among sarcopenia and its elements with depression and fatigue. **Method:** We used cross-sectional data from 2012 SABE (*Salud, Bienestar y Envejecimiento*)-Bogotá study, which included 2,000 participants of ages ≥60 years. Sarcopenia and its elements were taken as the dependent variable, while fatigue and depression were the main independent variables. We tested the association among these through multiple logistic regression models, which were fitted for each dependent variable and adjusted for confounding variables. **Results:** Our findings showed that gait speed was associated with fatigue (adjusted odds ratio [OR] = 1.41, 95% confidence interval [CI] = [1.05, 1.90], $p = .02$) as well as abnormal handgrip strength (adjusted OR = 1.40, 95% CI = [1.02, 1.93], $p = .04$). No other associations were significant. **Conclusion:** While sarcopenia and fatigue are not associated, two of the sarcopenia-defining variables are associated with fatigue; this suggests that lack of sarcopenia does not exclude undesirable outcomes related to fatigue in aging adults. Also, the lack of association between sarcopenia-defining elements and depression demonstrates that depression and fatigue are different concepts.

Keywords

sarcopenia, muscle strength, muscle mass, fatigue, depression

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Introduction

Sarcopenia is defined as a decrease in muscle mass and strength associated with aging, it is considered a multifactorial entity reflecting the interaction among genetic and behavioral mechanisms, comorbidities, and the aging process itself (Cruz-Jentoft, Landi, Topinková, & Michel, 2010; Evans, 2015). Said diagnosis is based on documentation of low muscle mass plus low muscle strength and/or low physical performance (Cruz-Jentoft, Landi, et al., 2010).

Sarcopenia is associated with adverse outcomes (Arango-Lopera, Arroyo, Gutiérrez-Robledo, Pérez-Zepeda, & Cesari, 2013; Cesari et al., 2015), such as mortality, disability, and institutionalization. Moreover, geriatric syndromes are highly prevalent, multifactorial conditions associated with poor outcomes and substantial morbidity, which are also associated among them (Inouye, Studenski, Tinetti, & Kuchel, 2007). Sarcopenia has been described as such, and as expected, it has been associated with other geriatric syndromes: depression, cognitive decline, falls, and malnutrition to name a few (Cruz-Jentoft, Landi, et al., 2010; Hsu et al., 2014; Visser & Schaap, 2011).

Depression is a common geriatric syndrome; however, it is frequently unrecognized which leads to inadequate treatment of the condition in older adults (Lapid &

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Rummans, 2003). In 2011 N. H. Kim et al. (2011) found that Korean older adults with depression had less skeletal mass. Hsu et al. (2014) found the same association in Taiwanese older adults. In addition, gait speed and handgrip strength which correlate to physical performance and muscle strength, respectively, have also been associated with depressive symptoms (Atkinson et al., 2007; Kaburagi et al., 2011). However, these studies have used scales that include somatic symptoms such as fatigue for screening of depression. A recent review on this symptom suggests that when it comes to older adults, fatigue may be a differentiated symptom, indicatory of real lack of energy which reflects the possibility of having sarcopenia or other geriatric conditions (Zengarini et al., 2015). Furthermore, fatigue is defined by *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013) as a common and distressing self-reported symptom perceived by the person while performing usual mental and physical activities (American Psychiatric Association, 2013), it is highly prevalent in older people, and strongly associated with negative health-related events, hence, it has been defined as both a symptom and a geriatric syndrome (Zengarini et al., 2015). Therefore, fatigue may be the only complaint of an older adult with sarcopenia, depression, or even frailty.

To determine whether depressive symptoms and fatigue are related differently with sarcopenia, the aim of this article is to evaluate the association between sarcopenia and its elements (muscle mass, gait speed, and handgrip strength) with depression and fatigue. To the best of our knowledge, there are no previous studies that have explored the association among these variables. However, treatments are available for said diseases. Therefore, we consider that this study could greatly contribute to the assessment and management of geriatric patients, thus ameliorating quality of life and decreasing burden of disease.

Materials and Method

Settings, Design, and Sampling

We analyzed data from the SABE (*Salud, Bienestar y Envejecimiento*) 2012 Bogotá survey, which is a cross-sectional study that included 2,000 participants aged 60 years or more, who lived in rural and urban areas in the city of Bogotá, Colombia. The instrument used in the SABE 2012 Bogotá study was derived from the international instrument designed for the original SABE study conducted in five Latin American capital cities between 1999 and 2000. However, it was modified and adapted to Colombian context. Further information about SABE study is available elsewhere (Albala et al., 2005). Probabilistic sampling, made by clusters (housing segments) and block stratification was representative of 779,539 participants aged 60 years and older; 81.9% of the sample corresponded to participants with complete data, which were included for the analysis. The informed consent, the survey questionnaire, and all study materials were approved by the ethics committee at Pontificia Universidad Javeriana.

Sarcopenia Assessment

Numerous classifications on how to categorize sarcopenia have been proposed; however, the diagnosis algorithm proposed by the European Working Group on Sarcopenia in Older People (EWGSOP) is highly accepted in clinical and research settings (Cruz-Jentoft, Baeyens, et al., 2010), therefore it was used to define the dependent variable (sarcopenia and its elements) in this study. As part of the anthropometric evaluation undergone by the study participants, gait speed, handgrip strength, and calf circumference were measured. Gait speed was measured by requesting the participant to walk 2.4 m (starting from standing position) at their usual pace; results were recorded in meters per second. Two measures were taken for each subject and the best timing of both was used for analysis. Four cutoff values were estimated for gait speed according to height (mean or higher and lower than the mean) and sex, by using the lowest quintile for each subgroup (Supplementary Table 1). Mean height value was 1.62 m for men, and 1.49 m for women. Handgrip strength was measured using a hydraulic handheld dynamometer. The subject was asked to perform three trials, of which the best was used for the analysis. Cutoff values for handgrip strength were determined by the lowest quintile for each body mass index (BMI) quartile (Q) and sex group. Consequently, eight values were obtained (Supplementary Table 1). BMI quartile values were in the following order (Q1-Q4): 20, 22, 24, and 24 kg/m^2 for men, and 12, 14, 13, and 14kg/m^2 for women. Finally, for muscle mass, calf circumference was measured in centimeters. The cutoff value for this variable was 31 cm or less, which classified participants as having abnormal muscle mass, as used in previous reports (Arango-Lopera, Arroyo, Gutiérrez-Robledo, & Pérez-Zepeda, 2012; Rolland et al., 2003). Sarcopenia was considered to be present if the subject had abnormal muscle mass with either abnormal gait speed (regardless of handgrip strength) or normal gait speed and abnormal handgrip strength.

Fatigue and Depression Measurements

Our main independent variables were fatigue and depression. Fatigue was assessed by inquiring the participants: "In the last week: how many times have you felt that everything you do is an effort?" with four possible answers: (a) rarely, (b) few times, (c) occasionally, and (d) most of the time; this variable was further dichotomized in "presence of fatigue" (c or d.) and "absence of fatigue" (a or b). To determine the presence or absence of depressive symptoms, we used Yesavage Geriatric Depression Scale (GDS), which consists of 15 questions that can be answered as "yes" or "no." A higher score

Table 1. Sample Characteristics Stratified by Sarcopenia Status.

Sample characteristics	Sarcopenic	Nonsarcopenic	Total (*N* = 1,509)	*p* value
Sex (female), *n* (%)	61 (6.5)	876 (93.5)	937 (62.1)	.381
Sex (male), *n* (%)	44 (7.7)	528 (92.3)	572 (37.9)	
Age, mean (*SD*)	76.29 (9.19)	70.27 (7.36)	70.69 (7.65)	<.001
Years of school, mean (*SD*)	4.29 (4.22)	5.42 (4.34)	5.34 (4.34)	.011
Marital status (living with a partner), *n* (%)	40 (5.35)	708 (94.65)	748 (49.57)	.015
Smoking status, *n* (%)	48 (6.82)	656 (93.18)	704 (46.65)	.836
Comorbidities, mean (*SD*)	2.10 (1.45)	1.89 (1.38)	1.90 (1.39)	.12
MMSE cognitive impairment, *n* (%)	19 (14.84)	109 (85.16)	128 (8.48)	<.001
GDS score, mean (*SD*)	4.14 (3.16)	3.61 (3.09)	3.65 (3.09)	.092
Fatigue, *n* (%)	31 (9.34)	301 (90.66)	332 (22.00)	.054
Functional dependence, *n* (%)	78 (9.84)	715 (90.16)	793 (52.55)	<.001
Falls in the last 12 months, *n* (%)	37 (8.94)	377 (91.06)	414 (27.44)	.063
Unintended loss of weight (5 kg), *n* (%)	7 (7.87)	82 (92.13)	89 (5.90)	.729
Gait speed, mean (*SD*)	0.57 (0.29)	0.81 (0.39)	0.79 (0.38)	<.001
Handgrip strength, mean (*SD*)	15.86 (6.96)	23.71 (10.2)	23.17 (10.2)	<.001
Calf circumference, mean (*SD*)	29.36 (1.51)	34.76 (3.07)	34.38 (3.29)	<.001

Note. MMSE = mini-mental state examination; GDS = Geriatric Depression Scale.

represents more depressive symptoms. Participants with a score of 6 points or higher were classified as having depression, as is currently done in clinical practice and research settings.

Confounding variables. Sociodemographic variables such as sex, age in years, and years in school were included. Marital status was dichotomized as "living with a partner" and "not living with a partner or not having one." The first variable enclosed "Legal union with cohabitation" and "Free union with cohabitation" as possible answers. "Legal union without cohabitation," "Free union without cohabitation," "Separation," "Widowhood," and "Singlehood" were included for the second category. The habit of smoking was also dichotomized as follows: (a) actually smokes and (b) former smoker as "smokers" and (c) had never smoked as "non-smokers."

Comorbidities were employed as a continuous variable resulting from the sum of the number of conditions an individual presented (0-10). This variable was assessed by inquiring: "Has a doctor or nurse ever told you that you suffer of . . . " for each medical condition: lung diseases (asthma, chronic obstructive pulmonary disease [COPD], bronchitis, emphysema), heart failure, coronary artery disease (heart attack, angina), gastrointestinal disorders (gastritis, ulcerous disease, gastro esophageal reflux), diabetes mellitus, hypertension, articular disorders (arthritis, rheumatism, arthrosis), osteoporosis, osteopenia, and stroke. Cognitive function was assessed by using the modified version of the mini-mental state examination (MMSE) validated in the initial SABE studies (Albala et al., 2005). The score ranges from 0 to 19 with a higher score representing better cognitive function—less than 13 points was considered as cognitive decline. Self-report was used to assess unintended loss of more than 5 kg of weight. Falls were evaluated asking the subject, "Have you fallen in the last 12 months?" with "yes" or "no" as possible answers. Functional dependence variable was created following the principle that "any difficulty is considered as functional dependence" (Kane & Kane, 2000), by combination of scores from Barthel and Lawton scales.

Statistical Analyses

Initially, we used univariate analyses to explore extreme values and a normal distribution to adjust and categorize variables, in order to keep a clinical focus. Regarding descriptive statistics, categorical variables are presented using frequencies and percentages, while means and standard deviations are used for continuous variables. Afterward, bivariate analysis was performed; chi-square tests were used for categorical variables, and *t* test was used for continuous variables. Finally, in multivariate analysis, logistic regression models were fitted to obtain the odds ratio (OR) with 95% confidence intervals (CIs) of having sarcopenia or its elements (having abnormal gait speed, grip strength or calf circumference), according to depression and fatigue. Estimates are presented before and after adjustment by sex, age, years of school, living with a partner, smokers, comorbidities, MMSE cognitive impairment, falls in the last 12 months, and unintended loss of weight. The statistical level of significance was set at $p < .05$. Data were analyzed using STATA 12®.

Results

The results are based on a sample of 1,509 older adults, 62.1% of them were women and 37.9% were men, 6.96% of the sample displayed sarcopenia (6.5% of women and 7.7% of men) ($p = .381$). On average, the

Table 2. Description of Sarcopenia Elements Stratified by Sex.

	Men	Women	Total (1,509)	*p* value
Sarcopenia, *n* (%)	44 (41.90)	61 (58.10)	105 (6.96)	.381
Sarcopenia categories, *n* (%)				
No sarcopenia	528 (37.61)	876 (62.39)	1,404 (93.04)	.381
Presarcopenia	26 (23.42)	85 (76.58)	111 (7.36)	.003
Moderate sarcopenia	15 (36.59)	26 (63.41)	41 (2.72)	.998
Severe sarcopenia	19 (54.29)	16 (45.71)	35 (2.32)	.028
Low gait speed, *n* (%)	174 (41.13)	249 (58.87)	423 (28.03)	.071
Low handgrip strength, *n* (%)	133 (37.68)	220 (62.32)	353 (23.39)	.969
Low muscle mass, *n* (%)	84 (28.87)	207 (71.13)	291 (19.28)	.002

Table 3. Description of Sarcopenia Elements by Age Categories.

	60-64	65-69	70-74	75-79	80 or more	Total (1,509)	*p* value
Sarcopenia, *n* (%)	18 (17.14)	11 (10.48)	16 (15.24)	15 (14.29)	45 (42.85)	105 (6.96)	<.001
Sarcopenia categories, *n* (%)							
No sarcopenia	376 (26.78)	347 (24.72)	290 (20.66)	215 (15.31)	176 (12.54)	1,404 (93.04)	<.001
Presarcopenia	27 (24.32)	31 (27.93)	22 (19.82)	13 (11.71)	18 (16.22)	111 (7.36)	.657
Moderate sarcopenia	8 (19.51)	4 (9.76)	7 (17.07)	6 (14. 63)	16 (39.02)	41 (2.71)	.003
Severe sarcopenia	6 (17.14)	2 (5.71)	7 (20)	5 (14.29)	15 (42.86)	35 (2.31)	.001
Low gait speed, *n* (%)	87 (20.57)	77 (18.20)	74 (17.49)	76 (17.97)	109 (25.77)	423 (28.03)	<.001
Low handgrip strength, *n* (%)	56 (15.86)	45 (12.75)	66 (18.70)	74 (20.96)	112 (31.73)	353 (23,39)	<.001
Low muscle mass, *n* (%)	51 (17.53)	52 (17.87)	50 (17.18)	36 (12.37)	102 (35.05)	291 (19.28)	<.001

age of the sarcopenic participants was 76.29 years, and 70.27 years for those without sarcopenia ($p < .001$). Participants had a mean of 5.34 years of school, 4.29 for sarcopenic participants and 5.42 for nonsarcopenic participants ($p = .011$). Roughly half of the sample (49.57%) was composed by participants living with a partner, 5.35% of them were sarcopenic ($p = .015$). Cognitive impairment was found in 8.48% of the sample, 14.84% of these were sarcopenic ($p < .001$), while functional dependence was found in 52.55%, coexisting with sarcopenia in 9.84% of these ($p < .001$). As for our dependent variables, 25.38% had depression, 8.09% of these also had sarcopenia ($p = .312$). On the contrary, fatigue was present in 22%, of which 9.34% were sarcopenic ($p = .054$). Regarding sarcopenia-defining variables, the mean for gait speed was 0.79 m/s (0.57 m/s for sarcopenic participants, and 0.81 m/s for nonsarcopenic participants), 23.17 kg for handgrip strength (15.86 kg for sarcopenic participants and 23.71 kg for nonsarcopenic participants), and 34.38 cm for calf circumference (29.36 cm in sarcopenic participants, and 34.76 cm for nonsarcopenic participants) ($p < .001$) (Table 1).

The proportion of sarcopenia was higher in participants who were 80 years or older (42.85%) than in other age groups ($p < .001$). When classifying sarcopenia we found the following: No sarcopenia in 93.04% of the sample, which was predominant in the 60 to 64 years age group (26.78%) ($p < .001$); presarcopenia in 7.36% of the sample, which was more prevalent in the 65 to 69 years age group ($p = .657$); moderate sarcopenia in 2.71% of the sample, which was predominant in participants who were 80 years or older ($p = .003$); and severe sarcopenia in 2.31% of the sample, which was more frequent in age group 80 or more ($p = .001$) (Tables 2 and 3). No sarcopenia, presarcopenia, and moderate sarcopenia were more frequent in women ($p = .381$, 0.003, 0.998, respectively). Severe sarcopenia was more prevalent in men ($p = .028$). Low gait speed, low handgrip strength, and low muscle mass were found more frequently among women ($p = .071$, 0.969, 0.002, respectively; Table 2). Low gait speed was found in 28.03% of the sample, 23.39% of the sample had low handgrip strength, and low muscle mass was identified in 19.28% of the sample; these three variables were most prevalent in the 80 years or older age group ($p < .001$; Table 3).

After multivariate analysis, sarcopenia did not display statistically significant association with either depression or fatigue. Abnormal gait speed exhibited association with depression in the unadjusted model (OR = 1.41, CI = [1.01, 1.82], $p = .007$); however, this association lost significance after adjustment. Abnormal gait speed showed association with fatigue, both before (OR = 1.68, CI = [1.3, 2.18], $p < .001$) and after adjustment (OR = 1.41, CI = [1.05, 1.90], $p = .02$). Abnormal handgrip strength did not display statistically significant association with depression; however, it did show an association with fatigue both before (OR = 1.69, CI = [1.28, 2.23], $p < .001$) and after adjustment (OR = 1.40, CI = [1.02, 1.93], $p = .04$). Abnormal calf circumference did not exhibit a statistically significant association with

Table 4. Multivariate Analysis Based on Dependent and Independent Variables of Interest.

	Depression		Fatigue	
	Not adjusted (95% CI), *p* value	Adjusted (95% CI), *p* value	Not adjusted (95% CI), *p* value	Adjusted (95% CI), *p* value)
Sarcopenia	1.25 [0.81, 1.94], .313	0.82 [0.50, 1.36], .45	1.53 [0.99, 2.38], .055	1.12 [0.68, 1.85], .64
Gait speed	1.41 [1.01, 1.82], .007	1.09 [0.82, 1.46], .552	1.68 [1.3, 2.18], <.001	1.41 [1.05, 1.90], .02
Handgrip strength	1.32 [1, 1.73], .05	0.97 [0.70, 1.33], .848	1.69 [1.28, 2.23], <.001	1.40 [1.02, 1.93], .04
Calf circumference	1.25 [0.91, 1.72], .168	1.13 [0.79, 1.61], .5	1.11 [0.79, 1.56], .537	0.90 [0.62, 1.32], .6

Note. CI = confidence interval.

either depression or fatigue (Table 4). Missing data did not change statistical significance after bootstrapping (data available upon request).

Discussion and Conclusion

Our data report a 6.96% prevalence for sarcopenia, a midterm value when comparing it with prevalences from other countries around the world, which were obtained through similar methodologies based on variable statification cutoff values for community-dwelling populations: prevalences range from 24.2% in Japan, 12.5% in Belgium, 10.2% in Italy, and 7.8% in Taiwan to 6.8% in United Kingdom, 6.0% in Canada, and 5% in the United States (Cruz-Jentoft et al., 2014). The prevalence of sarcopenia reported by this study is lower than a previous one obtained in a sample of 108 elderly patients in 2013 in Bogotá, Colombia (38.9%; Díaz Muñoz, Cárdenas Zuluaga, & Mesa Jimenez, 2015). However, we must take into account that cutoff values for defining sarcopenia in the majority of these studies were the same as those originally proposed by the EWGSOP. This creates an obstacle when comparing previous results to ours given that the prevalence of sarcopenia obtained with tailored cutoff values decreases, probably leading to a better EWGSOP algorithm performance (Lourenço, Pérez-Zepeda, Gutiérrez-Robledo, García-García, & Rodríguez Mañas, 2015). Also, some of the studies used the International Working Group on Sarcopenia (IWGS) diagnosis approach. Another issue arises when considering that some of these studies used dual-energy X-ray absorptiometry (DXA) or bioelectrical impedance (BIA) to measure muscle mass in contrast to the calf circumference measure. Moreover, the previously mentioned Bogotá study was conducted in nursing homes, while our sample was composed of community-dwelling older adults.

In our attempt to accomplish our main goal, to determine an association among sarcopenia and its elements and other geriatric syndromes (depression and fatigue), we found that there was a statistically significant association between depression and abnormal gait speed, as well as between depression and handgrip strength. We also encountered a significant association between fatigue and the same two sarcopenia-defining elements. Nevertheless, depression associations lost statistical significance when adjusted for confounding variables. Interestingly, fatigue association remained significant; some of these results are contradictory regarding literature. In 2011, N. H. Kim et al. (2011) determined an association between sarcopenia and depression. As stated previously, this could be explained by the association that exists with the items related to fatigue in the different scales used to define depressive symptoms, and not differentiating them.

Complex geriatric syndromes fatigue and depression have a bidirectional association (Unützer, 2007). Depression is made up of two general constructs: psychological, which includes affective and cognitive elements, and somatization/activity. Therefore, as fatigue is part of the somatization/activity construct, a depression diagnosis cannot be made if only fatigue is present. This leads us to understand how depression and fatigue are different concepts (Zengarini et al., 2015). This explains why fatigue persists with a risk association after adjustment and depression does not: only the somatization/activity construct of depression seems to be affected in sarcopenia.

Another important point is that perhaps the "one pathology at a time" type of assessment, like the EWGSOP algorithm proposes, is not the best way to make an integral approach toward geriatric patients (Bijlsma et al., 2014). In this case, if the patient has got abnormal gait speed and handgrip strength but normal muscle mass, the diagnosis of sarcopenia will not be made, and therefore, treatment options will not be presented. This could be a relevant mistake if we take into account that this particular patient has a high probability of having fatigue, which untreated can result in adverse outcomes. This is demonstrated by the fact that having abnormal gait speed or abnormal handgrip strength (particularly) are more reliable indicators for 5-year adverse clinical outcomes of mortality than muscle mass, the principal element in the EWGSOP (Y. H. Kim et al., 2016; Rijk, Roos, Deckx, van den Akker, & Buntinx, 2016; Stenholm et al., 2016). Moreover, having only fatigue could herald the presence of sarcopenia as a whole construct.

This study acknowledges some limitations. The fact that it is a cross-sectional study impedes to forecast or

establish causality, but merely association, which allows us to generate hypotheses that must be proven right in future studies. Also, recall bias could affect our results because some variables, such as fatigue (one of our main independent variables), are self-reported. Finally, the collected data come from only one city of the country, possibly limiting generalization (selection bias).

To the best of our knowledge, this is the first study to explore the association among sarcopenia as a whole—its elements—fatigue and depression. In addition, as previously explained, this study demonstrates the importance of taking fatigue and individual elements of sarcopenia into account even when sarcopenia as a whole cannot be diagnosed. Furthermore, both sarcopenia and fatigue can be treated, which increases applicability for this study.

Finally, further investigation should confirm this association and establish causality; also additional focus on complex and exact pathophysiological mechanisms that would explain this relationship is required to design accurate treatments. These data contribute importantly to the geriatric syndromes approach in Latin American countries.

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Supplemental Material

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References

Albala, C., Lebrão, M. L., Díaz, L., María, E., Ham-Chande, R., Hennis, A. J., . . . Pratts, O. (2005). The Health, Well-Being, and Aging ("SABE") Survey: Methodology applied and profile of the study population. *Revista Panamericana de Salud Pública*, *17*, 307-322. doi:10.1590/S1020-49892005000500003

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington, VA: American Psychiatric Publishing. Retrieved from http://psychiatryonline.org/doi/book/10.1176/appi.books.9780890425596

Arango-Lopera, V. E., Arroyo, P., Gutiérrez-Robledo, L. M., & Pérez-Zepeda, M. U. (2012). Prevalence of sarcopenia in Mexico City. *European Geriatric Medicine*, *3*, 157-160. doi:10.1016/j.eurger.2011.12.001

Arango-Lopera, V. E., Arroyo, P., Gutiérrez-Robledo, L. M., Pérez-Zepeda, M. U., & Cesari, M. (2013). Mortality as an adverse outcome of sarcopenia. *The Journal of Nutrition, Health & Aging*, *17*, 259-262. doi:10.1007/s12603-012-0434-0

Atkinson, H. H., Rosano, C., Simonsick, E. M., Williamson, J. D., Davis, C., Ambrosius, W. T., . . . Health ABC Study. (2007). Cognitive function, gait speed decline, and comorbidities: The health, aging and body composition study. *The Journals of Gerontology, Series A: Biological Sciences & Medical Sciences*, *62*, 844-850.

Bijlsma, A. Y., Meskers, C. G. M., van den Eshof, N., Westendorp, R. G., Sipilä, S., Stenroth, L., . . . Maier, A. B. (2014). Diagnostic criteria for sarcopenia and physical performance. *Age*, *36*(1), 275-285. doi:10.1007/s11357-013-9556-5

Cesari, M., Rolland, Y., Abellan Van Kan, G., Bandinelli, S., Vellas, B., & Ferrucci, L. (2015). Sarcopenia-related parameters and incident disability in older persons: Results from the "invecchiare in Chianti" study. *The Journals of Gerontology, Series A: Biological Sciences & Medical Sciences*, *70*, 457-463. doi:10.1093/gerona/glu181

Cruz-Jentoft, A. J., Baeyens, J. P., Bauer, J. M., Boirie, Y., Cederholm, T., Landi, F., . . . European Working Group on Sarcopenia in Older People. (2010). Sarcopenia: European consensus on definition and diagnosis: Report of the European working group on sarcopenia in older people. *Age and Ageing*, *39*, 412-423. doi:10.1093/ageing/afq034

Cruz-Jentoft, A. J., Landi, F., Schneider, S. M., Zúñiga, C., Arai, H., Boirie, Y., . . . Cederholm, T. (2014). Prevalence of and interventions for sarcopenia in ageing adults: A systematic review. Report of the International Sarcopenia Initiative (EWGSOP and IWGS). *Age and Ageing*, *43*, 748-759. doi:10.1093/ageing/afu115

Cruz-Jentoft, A. J., Landi, F., Topinková, E., & Michel, J.-P. (2010). Understanding sarcopenia as a geriatric syndrome. *Current Opinion in Clinical Nutrition and Metabolic Care*, *13*, 1-7. doi:10.1097/MCO.0b013e328333c1c1

Díaz Muñoz, G. A., Cárdenas Zuluaga, D. M., & Mesa Jimenez, A. (2015). Consistency of mini nutritional assessment to identify sarcopenia in older adults in nursing homes in Bogota, Colombia. *Nutrición Hospitalaria*, *32*(1), 270-274. doi:10.3305/nh.2015.32.1.8816

Evans, W. J. (2015). Sarcopenia should reflect the contribution of age-associated changes in skeletal muscle to risk of morbidity and mortality in elderly people. *Journal of the American Medical Directors Association*, *16*, 546-547. doi:10.1016/j.jamda.2015.03.021

Hsu, Y.-H., Liang, C.-K., Chou, M.-Y., Liao, M.-C., Lin, Y.-T., Chen, L.-K., & Lo, Y.-K. (2014). Association of cognitive impairment, depressive symptoms and sarcopenia among healthy older men in the veterans retirement community in Southern Taiwan: A cross-sectional study.

Geriatrics & Gerontology International, *14*(Suppl. 1), 102-108. doi:10.1111/ggi.12221

Inouye, S. K., Studenski, S., Tinetti, M. E., & Kuchel, G. A. (2007). Geriatric syndromes: Clinical, research and policy implications of a core geriatric concept. *Journal of the American Geriatrics Society*, *55*, 780-791. doi:10.1111/j.1532-5415.2007.01156.x

Kaburagi, T., Hirasawa, R., Yoshino, H., Odaka, Y., Satomi, M., Nakano, M., . . . Sato, K. (2011). Nutritional status is strongly correlated with grip strength and depression in community-living elderly Japanese. *Public Health Nutrition*, *14*, 1893-1899. doi:10.1017/S1368980011000346

Kane, R., & Kane, R. (2000). *Assessing older persons: Measures, meaning, and practical applications*. New York, NY: Oxford University Press.

Kim, N. H., Kim, H. S., Eun, C. R., Seo, J. A., Cho, H. J., Kim, S. G., . . . Kim, N. H. (2011). Depression is associated with sarcopenia, not central obesity, in elderly Korean men. *Journal of the American Geriatrics Society*, *59*, 2062-2068. doi:10.1111/j.1532-5415.2011.03664.x

Kim, Y. H., Kim, K.-I., Paik, N.-J., Kim, K.-W., Jang, H. C., & Lim, J.-Y. (2016). Muscle strength: A better index of low physical performance than muscle mass in older adults. *Geriatrics & Gerontology International*, *16*, 577-585. doi:10.1111/ggi.12514

Lapid, M. I., & Rummans, T. A. (2003). Evaluation and management of geriatric depression in primary care. *Mayo Clinic Proceedings*, *78*, 1423-1429. doi:10.4065/78.11.1423

Lourenço, R. A., Pérez-Zepeda, M., Gutiérrez-Robledo, L., García-García, F. J., & Rodríguez Mañas, L. (2015). Performance of the European Working Group on Sarcopenia in Older People algorithm in screening older adults for muscle mass assessment. *Age and Ageing*, *44*, 334-338. doi:10.1093/ageing/afu192

Rijk, J. M., Roos, P. R., Deckx, L., van den Akker, M., & Buntinx, F. (2016). Prognostic value of handgrip strength in people aged 60 years and older: A systematic review and meta-analysis. *Geriatrics & Gerontology International*, *16*, 5-20. doi:10.1111/ggi.12508

Rolland, Y., Lauwers-Cances, V., Cournot, M., Nourhashémi, F., Reynish, W., Rivière, D., . . . Grandjean, H. (2003). Sarcopenia, calf circumference, and physical function of elderly women: A cross-sectional study. *Journal of the American Geriatrics Society*, *51*, 1120-1124.

Stenholm, S., Koster, A., Valkeinen, H., Patel, K. V., Bandinelli, S., Guralnik, J. M., & Ferrucci, L. (2016). Association of physical activity history with physical function and mortality in old age. *The Journals of Gerontology, Series A: Biological Sciences & Medical Sciences*, *71*, 496-501. doi:10.1093/gerona/glv111

Unützer, J. (2007). Clinical practice. Late-life depression. *The New England Journal of Medicine*, *357*, 2269-2276. doi:10.1056/NEJMcp073754

Visser, M., & Schaap, L. A. (2011). Consequences of sarcopenia. *Clinics in Geriatric Medicine*, *27*, 387-399. doi:10.1016/j.cger.2011.03.006

Zengarini, E., Ruggiero, C., Pérez-Zepeda, M. U., Hoogendijk, E. O., Vellas, B., Mecocci, P., & Cesari, M. (2015). Fatigue: Relevance and implications in the aging population. *Experimental Gerontology*, *70*, 78-83. doi:10.1016/j.exger.2015.07.011