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Dynapenia and Sarcopenia as a Risk Factor for Disability in a Falls and Fractures Clinic in Older Persons

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Abstract

BACKGROUND: The role of sarcopenia and dynapenia in disability in older persons from falls and bone health clinics remain unknown.

AIM: This study aims to compare the association of sarcopenia and dynapenia with physical and instrumental disability in a population of older persons attending a falls and fractures clinic.

METHODS: This is a cross-sectional study in Manizales, Andes Mountains, Colombia. A cohort of 534 subjects (mean age = 74, 75% female) Sarcopenia was measured according to the European Working Group on Sarcopenia in Older People (EWGSOP) including an index of skeletal mass, muscle strength, and gait speed. Dynapenia was defined as a handgrip force ≤ 30 kg for men and ≤ 20 kg for women.

RESULTS: Dynapenia and sarcopenia were present in 84.6% and 71.2% respectively. Both were more prevalent in older subjects and women than men. While sarcopenia was associated with body mass index and hypertension, dynapenia was associated with hypothyroidism and visual impairment. After controlling for all covariates, sarcopenia was associated with low IADL and mobility disability.

CONCLUSIONS: Sarcopenia was associated with mobility, ADL and IADL disability. Dynapenia was not associated with disability in this high - risk population. Systematic assessment of sarcopenia should be implemented in falls and fractures clinics to identify sarcopenia and develop interventions to prevent functional decline among elderly individuals.

Introduction

Sarcopenia has been defined as a loss of muscle mass and muscle strength related to ageing. [1][2]. However, there are divergences about the mechanisms, definitions and measurements of sarcopenia. The main point of discussion is the inclusion of muscle mass and strength in the same concept because the decline in muscle strength can be attributed to a combination of muscular and neural factors and not only to reduced muscle mass [3]. At the same time, recent data from longitudinal studies on ageing indicate that maintaining or gaining muscle mass does not prevent aging-related decline in muscle strength [4][5]. Dynapenia (Greek translation for the poverty of strength, power, or force) is the age-associated loss of muscle strength that is not caused by neurologic or muscular diseases [6]. Low muscle strength is well known to place older adults at an increased risk of mobility limitations and mortality [6]. Accordingly, the preservation of muscle strength and power with advancing age is of high clinical significance.

Since dynapenia is only partially explained by the reduction in muscle mass (sarcopenia), several authors insist that these two conditions need to be defined independently of one another [7]. However, The European Working Group on Sarcopenia in Older People (EWGSOP) recommendations for a diagnosis of sarcopenia, which is widely disseminated in clinical

practice, includes not only the presence of low muscle mass (LMM) but also low muscle strength (LMS) and/or low physical performance (LPP) [8]. Recent studies have highlighted the relationship between sarcopenia and falling [9][10]. Indeed, we previously identified a phenotype of osteosarcopenia in older individuals with a history of falling in a fall and Fractures Clinic in Australia [11]. However, the role of sarcopenia and dynapenia in disability in this high-risk population remains unexplored.

Also, few studies have been carried on in Latin America about sarcopenia o dynapenia as a predictor of disability [12][13].

Therefore, the present study aims to compare the association of disability with either EWGSOP - defined sarcopenia or dynapenia in a high - risk population of older fallers in Colombia.

Materials and Methods

Study population

This is cross-sectional study. The setting was the Falls, Dizziness, and Fractures Clinic at University of Caldas (Manizales, Andes Mountains, Colombia, South America). The participants were 534 subjects (mean age = 74, 75% female) assessed between January 2002 - 2014. To be included in the study, participants had to be at least 60 years old and have a complete data set. Participants were excluded based on severe medical conditions that may significantly affect their mobility or incomplete registration of data.

Eligibility criteria to attend the falls, dizziness and fractures clinic included ability to mobilize with a walker or cane(s), willingness to attend the clinic, and at least one of the following: multiple faller (more than two in the last year), single faller with established gait and/or balance problem (e.g., by Get Up and Go Test), unexplained fall with apparent complex medical cause(s), history of chronic dizziness (last 5 years and no earlier than 3 months) and/or history of self - reported symptomatic or asymptomatic fragility fracture(s). The University of Caldas Ethics Research Committee approved this study.

Dependent variables: disability

Respondents were asked if they had difficulty performing activities of daily living (ADL) using a Spanish version of the Barthel ADL scale [14]. If the respondents indicated difficulty or inability in performing one or more of the tasks, they were scored as having ADL disability. Despite its importance about functionality in elderly individuals, incontinence was not included in ADL because it does not necessarily imply physical limitation [15]. For the instrumental activities of daily living (IADL), respondents were asked if they were able to perform eight activities (using a telephone, shopping, preparing meals, performing light housework, taking medications, managing money, doing heavy housework and using transportation), using a modified Spanish version of the Lawton IADL scale [16]. If respondents indicated difficulty or inability in performing one or more of the tasks, they were scored as having IADL disability. A summary score for mobility, ADL and IADL variables was computed. The final disability variable was hierarchical, with three levels. A score of 0 indicated no mobility, ADL or IADL limitation; 1 indicated any IADL limitation or a mobility limitation, and 2 indicated IADL and ADL limitations [17].

Independent Variables

Muscle mass was estimated by appendicular skeletal muscle mass (ASM) using the Lee equation as follow [18]: ASM = (0.244 * body weight) + (7.8 * height) + (6.6 * gender) – (0.098 * age) + (race – 3.3). Body weight was measured in kilograms (kg), and height was measured in meters. This equation has been validated in older population from Latin America using dual-energy X-ray absorptiometry (DXA) as a gold standard with a high correlation between methods ($r = 0.86$ for men and $r = 0.90$ for women, respectively, $p < 0.05$) [19]. After estimating the values, we adjusted the ASM by height squared to create the skeletal muscle mass index (SMI).

Following the studies of Delmonico et al. [20] and Newman et al. [21], the cutoff for LMM used was based on the 20% lowest percentile of the population distribution, representing SMI of ≤ 6.37 kg/m^2 for women and ≤ 8.90 kg/m^2 for men. Muscle strength was assessed with handgrip strength in kg using a hand-held dynamometer (Takey hydraulic dynamometer, the Smedley Hand Dynamometer III). Grip size was adjustable so that each participant felt comfortable while squeezing the grip. The test was performed twice in the dominant limb with a 1 - minute rest between tests and the higher value of the two trials was used for scoring. Cutoff values of < 30 kg for men and < 20 kg for women were considered to represent Low Muscle Strength [8][22].

The Spanish validated the version of Physical performance was assessed with gait speed (in meters/second), determined using the walk test of the Short Physical Performance Battery assessing Lower Extremity Function. The faster of the two trials was used for analyses [23]. The cut - off point of ≤ 0.8 m/s was used to represent LPP [8][22].

Sarcopenia was defined using the EWGSOP criteria. Participants with LMM plus either LMS or LPP were considered as having sarcopenia [8]. Dynapenia was defined using the criteria of Laurentani et al. [22]: < 30 kg for men and < 20 kg for women.

Covariates

Demographic characteristics were age, gender, marital status and education. Education was measured as years of formal schooling completed and was analysed as a continuous variable. (range, 0 to 18). Health status variables included perceived health status, chronic conditions, visual and auditory impairment, depression and cognitive status. The presence of seven chronic conditions (osteoarthritis, hypertension, diabetes mellitus, stroke, chronic obstructive pulmonary disease, and hypothyroidism) was ascertained through self - report. Physical performance was assessed with gait speed (in meters/second), determined using the walk test of the Short Physical Performance Battery Assessing Lower Extremity Function [23]. The faster of the two trials was used for analyses. The cut - off point of ≤ 0.8 m/s was used to represent LPP [8]. Falls and hospitalisations in the previous 12 months were assessed. Sensory impairments were assessed by asking for troubles with vision and hearing (yes or no). Cognition was assessed by the Mini-Mental State Examination; participants with a score of less than 20 were considered to be cognitively impaired [24][25]. An abbreviated (score 0 to 15) Spanish-validated Geriatric Depression Scale (GDS - S) was used to assess the presence of depressive symptoms [26]; respondents with a score of 6 or more on GDS - S are considered likely to be depressed. Body mass index (BMI) was computed by dividing weight in kilograms by height in square meters (kg/m^2).

Statistical analyses

The characteristics of the participants were described by means and standard deviations (SD) or frequencies and percentages according to the type of variable (continuous or categorical, respectively). The chi-square test was used to test qualitative data, while analysis of variance (ANOVA) was used to evaluate continuous data. Statistical differences between groups were determined. To identify the factors associated with disability, variables were selected based on the strength of the associations, higher prevalence (10% or more), clinical relevance, and low potential for collinearity. We calculated OR and 95% confidence intervals (CI). A three-step procedure was developed. First, univariate logistic regression analyses were used to describe the unadjusted effect of sarcopenia and dynapenia and covariates, in the second step, multivariate linear regression models were created to adjust by potential confounder covariates. Based on previous results, we proceeded with multivariate analysis using multiple multinomial logistic regressions, which estimates the prevalence odds ratios (OR). Model 1 includes sarcopenia as an independent variable and model 2 includes dynapenia. Statistical analyses were performed using SPSS for Windows version 22.0.

Results

The mean age ± standard deviation of the participants was 74.4 ± 8.2 years; 75.5% were female, 41.1% were married and the mean years of scholarly were 6.2 ± 4.4. The most prevalent medical conditions were hypertension (65.9%), hypothyroidism (21.9%) and diabetes (15.5%). Sarcopenia and dynapenia were present in 84.6% and 71.2% of the participants, respectively. Table 1 shows the baseline characteristics of the total sample and by sarcopenia and dynapenia status. Participants with sarcopenia and dynapenia were significantly more likely to be older. Those with dynapenia were more female and reported more hypothyroidism, falls and visual impairments, while those with sarcopenia had lower BMI and reported more hypertension. Visual and auditory impairments were reported by 80.4 % and 49.3% of the participants, respectively.

Table 1: Characteristics of the total sample and by sarcopenia and dynapenia status at baseline in clinic of fractures, falls and dizziness

Characteristic	Total sample N = 534	No Sarcopenia N = 154 (15.4)	Yes Sarcopenia N = 380 (84.6)	Yes Dynapenia N = 452 (71.2)	No Dynapenia N = 82 (28.8)
Sociodemographics					
Age, mean (DE)	74.4 (8.2)	74 (7.9)*	76 (8.3)*	75.9 (8.1) **	72.6 (8.6) **
80 or more years (%)	173 (32.4)	42 (27.3)	131 (34.5)	156 (34.5)	17 (20.7)
Women (%)	403 (75.5)	117 (76)	286 (75.3)	364 (80.5)**	39 (47.6)**
Schooling (years) (Mean DE)	6.24 (4.4)	5.9 (4.2)	6.4 (4.5)	6.4 (4.4)*	5.5 (4.4)*
Marital status (single) (%)	77 (14.4)	15 (9.7)	62 (16.3)	72 (15.9)	5 (6.1)
Self perceived health Bad /very bad (%)	73 (13.8)	22 (14.2)	51 (13.6)	61 (13.7)	12 (14.6)
Health conditions					
Hipertension (yes)	344 (65.9)	114 (75)**	230 (62.2)**	294 (66.5)	50 (62.5)
Cancer	26 (5)	8 (5.3)	18 (4.9)	23 (5.2)	3 (3.8)
Stroke	43 (8.4)	18 (12.1)	25 (6.9)	39 (9)	4 (5)
Diabetes (yes)	81 (15.5)	31 (20.3)	50 (13.5)	73 (16.4)	8 (10)
Osteoartritis (yes)	33 (6.3)	8 (5.3)	25 (6.7)	29 (6.5)	4 (5)
Hipothiroidism	115 (21.9)	42 (27.5)	73 (19.7)	108 (24.3) **	7 (8.8) **
COPD	55 (10.7)	13 (8.7)	42 (11.4)	48 (11)	7 (8.8)
Falls in last year (yes)	309 (60.4)	216 (59.5)	93 (62.4)	261 (72.7)*	38 (47.5)*
Hospitalization last year (yes)	289 (54.1)	80 (51.9)	209 (55)	246 (54.4)	43 (52.4)
Vision impairment (yes)	426 (80.4)	122 (79.7)	304 (80.6)	370 (82.4) **	56 (69.1) **
Hearing impairment (yes)	255 (49.3)	76 (50.7)	179 (48.8)	207 (47.4)*	48 (60)*
BMI: mean (DE)	26 (7.1)	30.3 (6.7) **	24.2 (6.4) **	25.6 (7.06)	28 (6.9)
Cognitive status MMSE < 20 (%)	66 (12.4)	14 (9.1)	52 (13.7)	59 (13.1)	7 (8.5)
Depressive symptoms GDS > 5 (n %)	233 (43.4)	76 (49.4)	156 (41.1)	205 (45.4)	27 (32.9)
Physical performance (SPPB)					
Gait Speed (M/seg). mean (DE)	0,80 (0.99)	0.91 (1.15)**	0.54(0.17)**	0.73 (0.62)*	1.18 (2.03)*

* P<0.05; **P<0.01.

In the bivariate analysis, there were strong associations between dynapenia and age (OR = 1.06, 95% CI = 1.01 - 1.11, p = 0.01), sex (OR = 1.16, 95% CI=1.16 - 1.31, P < 0.01), hypothirodism (OR = 6.09, 95% CI = 1.56 – 23.7, p < 0.01) and visual impairment (OR = 2.21 (1.03 - 4.75, p < 0.01). While significant associations were noted between sarcopenia and age (OR = 1.04, 95% CI = 1.0 - 1.08, p < 0.01), sex (OR = 1.37, 95% CI = 1.00 – 2.51, p = 0.29) and BMI (OR = 1.02, 95% CI = 1.0 – 1.09, p < 0.01).

Table 2 presents the weighted multinomial regression analysis for disability. In model 1, the following were risk factors for incidence in mobility or IADL disability: age and sarcopenia; some falls had a marginal statistical relationship. The risk factors for

ADL and IADL disability were: age, female and sarcopenia. In model 2 the same risk factors were found. However, dynapenia was not associated with disability.

Table 2: Weighted multinomial regression analysis for disability

	Mobility or IADL Sarcopenia model N = 259 OR (95%)	ADL and IADL Sarcopenia model n= 144 OR (95%)	Mobility or IADL Dynapenia model n= 332 OR (95%)	ADL and IADL Dynapenia model n= 192 OR (95%)
Age	1.09 (1.05–1.11)	1.12 (1.08 – 1.16)	1.08 (1.05-1.12)	1.11 (1.08 – 1.15)
Sex (female)	1.50 (0.87 – 2.58)	2.29 (1.32 – 3.96)	1.43 (0.81 – 2.52)	1.97 (1.11 – 3.49)
Hypertension	0.67 (0.40 – 1.12)	0.78 (0.48 – 1.27)	0.63 (0.38 – 1.04)	0.71 (0.43 – 1.15)
Hypothyroidism	1.52 (0.83– 2.80)	1.15 (0.65 – 2.03)	1.45 (0.79 – 2.66)	1.13 (0.64 – 1.98)
Falls (number)	1.01 (0.93- 1.11)	1.06 (0.98 – 1.14)	1.02 (0.94 – 1.11)	1.06 (0.98 – 1.15)
Visual impairment	1.24 (0.69 – 2.23)	0.70 (0.30 – 1.65)	1.34 (0.74 – 2.42)	1.29 (0.71 – 2.33)
Sarcopenia	2.03 (1.16 - 3.53)	2.03 (1.18 – 3.50)	-	-
Dynapenia	-	-	0.87 (0.45-1.67)	0.52 (0.26 – 1.06)

Discussion

Sarcopenia, according to the EWGSOP, was associated with low mobility and disability. Our data correspond with those previous reports [12][27] by showing an association between LMM, LMS and LPP and IADL, mobility and ADL disability. In addition, studies in different settings as community-dwelling older people [28][29][30][31][32][33][34][35][36], acute care [37][38][39] and nursing homes [40][41] showed a significant association between sarcopenia and functional limitation and disability.

Our results also correspond with other studies in Latin America, which have demonstrated that sarcopenia is a risk factor for disability in the elderly. In a four year prospective study in 478 individuals from SABE study, founded after controlling for all covariates, Aleixandre et al., reported that sarcopenia was associated with mobility or IADL disability [12]. Similar to our results, dynapenia was not associated with disability. In another cross-sectional study in 90 hospitalised women in Mexico City, Velasquez - Alba et al., reported that sarcopenia was associated with difficulties in mobility, particular difficulties in climbing stairs [42].

To the best of our knowledge, this is the first paper testing the role of sarcopenia in the clinical measurements performed at falls and fractures clinics. The prevalence of sarcopenia is difficult to establish. The percentage of sarcopenia (84.6%) found in our study is higher than reported for older people living in the community (1-29%), for those living in long-term care institutions (14-33% and up to 68% in men), and for those in acute hospital care 10% [43]. In another study about of sarcopenia in geriatric outpatient clinics, a prevalence of sarcopenia was higher in women (22.9%) than in men (12.7%) [44]. Indeed, this prevalence can differ depending on the characteristics of the studied population and the cut off applied for measuring [45]. Our sample had a mean walk speed of 0.8 mt/sec and cut off point for EWGSOP criteria by sarcopenia case finding [8]. Another possible reason is the eligibility criteria of the sample, with complex medical problems, chronic dizziness and symptomatic or asymptomatic fragility fracture(s). Furthermore, muscle mass reflects ethnicity and lifestyle characteristics [32]. As a consequence, more data are required to determine standardised cut - off values for sarcopenia in falls and fracture clinics. However, the findings here and elsewhere [27][28][29] support the view that intervention strategies designed to preserve skeletal muscle mass should be initiated in all older people attending falls and fracture clinics.

Sarcopenia as a risk factor for falls in elderly individuals remains controversial. In this study, we could not find an association between sarcopenia (based on muscle mass) and fall number in the last year. There are conflicting reports regarding the relationship of sarcopenia with fall. Our findings are in agreement with the results of several cross-sectional surveys on sarcopenia [27][28], but other study using EWGSOP criteria examined 260 individuals aged 80 years or older in Italy found that sarcopenic individuals had a high risk of fall incidents compared with non-sarcopenic individuals [46] Another study in Japan with the same criteria examined 1160 individuals aged 65 years or older revealed that sarcopenia was significantly associated with a history of fall [9].

This study has some limitations. First, the use of the use of the regression equation to estimate muscle mass may overestimate the prevalence of sarcopenia. The availability of DXA as “gold standard” for measuring sarcopenia is limited in coffee grower zones in Colombian Andes Mountains. However, this equation has been used previously in assessing Latin American populations [18][19]. Second, the study design was cross-sectional, and the results do not establish cause-effect relationships between sarcopenia and disability and falls. Theoretically, certain types of morbidity (e.g., lung disease, stroke, and uncontrolled noninsulin - dependent diabetes mellitus) could produce sarcopenia that would result in functional impairment and disability. It is also possible that disability could lead to sarcopenia by limiting physical activity and subsequently predisposing people to some chronic diseases. Also, none of the chronic diseases was significantly associated with sarcopenia, except hypertension. Third, we used handgrip strength and usual walking speed cutoff values that were based on values derived from other reference population. Future studies are required to determine the optimal muscle strength and physical performance cutoff values for defining sarcopenia on this population.

This study has several strengths. First, it was conducted on a large sample of patients comes from falls, dizziness and fractures clinic in Latin America. Second, this study is the first to analyse sarcopenia using the EWGSOP criteria at a falls, dizziness and fracture clinic and to compare this method with dynapenia as a risk factor for mobility, IADL, disability and ADL disability.

In conclusion, sarcopenia is a risk factor for developing IADL, mobility and ADL disabilities in older people. The diagnostic criteria from (EWGSOP) using normative data should be implemented at falls and fractures clinics to identify sarcopenia and develop early interventions to prevent functional decline among this population of high-risk elderly individuals.

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