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ORIGINAL ARTICLE / *ARTIGO ORIGINAL*

Prevalence and associated factors of sarcopenia, dynapenia, and sarcodynapenia in community-dwelling elderly in São Paulo – SABE Study

Prevalência e fatores associados à sarcopenia, dinapenia e sarcodinapenia em idosos residentes no Município de São Paulo – Estudo SABE

Tiago da Silva Alexandre[I], Yeda Aparecida de Oliveira Duarte[II], Jair Lício Ferreira Santos[III], Maria Lúcia Lebrão[IV]*

ABSTRACT: ***Objectives:*** To estimate the prevalence of sarcopenia, dynapenia, and sarcodynapenia and associated factors in older adults in the city of São Paulo, Brazil. ***Methods:*** A population-based, cross-sectional study was conducted with 1,168 older adults who participated in the third wave of the Health, Well-being, and Aging study in 2010 (SABE study). Men and women with skeletal muscle mass ≤ 8.90 and ≤ 6.37 kg/m^2, respectively, were considered sarcopenic. Men and women with grip strength < 30 and < 20 kg, respectively, were considered dynapenic. Those with both conditions were considered sarcodynapenic. Sociodemographic, behavioral, clinical, nutritional, and biochemical characteristics were investigated as factors associated with each of the three conditions using multinomial logistic regression. ***Results:*** The prevalence of sarcopenia, dynapenia, and sarcodynapenia was 4.8% (95%CI 3.6 – 6.3), 30.9% (95%CI 27.5 – 34.6) and 9.0% (95%CI 7.2 – 11.3), respectively. An increase in age and malnutrition was associated with all the three conditions. Cognitive impairment was associated with both dynapenia and sarcodynapenia. Schooling, current smoking habit, and not having a marital life were associated with sarcopenia. Osteoarthritis, schooling, being an ex-smoker, and low hemoglobin were associated with dynapenia. Smoking habit and the risk of malnutrition were associated with sarcodynapenia. ***Conclusion:*** Dynapenia is more prevalent among older adults, followed by sarcodynapenia, and sarcopenia. With the exception of age, schooling, and malnutrition, the factors associated with sarcopenia and dynapenia are different. However, there are similarities in some associations regarding the presence of sarcodynapenia.

Keywords: Sarcopenia. Dynapenia. Muscle Weakness. Muscle Skeletal. Aged. Prevalence.

[I]Department of Gerontology, Universidade Federal de São Carlos – São Carlos (SP), Brazil.
[II]Department of Medical-Surgical Nursing, School of Nursing, Universidade de São Paulo – São Paulo (SP), Brazil.
[III]Department of Social Medicine, Universidade de São Paulo – Ribeirão Preto (SP), Brazil.
[IV]Department of Epidemiology, School of Public Health, Universidade de São Paulo – São Paulo (SP), Brazil.
**in memoriam.*
Corresponding author: Tiago da Silva Alexandre. Departamento de Gerontologia da Universidade Federal de São Carlos. Rodovia Washington Luís, km 235, SP 310, CEP: 13565-905, Sala 16, São Carlos, SP, Brasil. E-mail: tiagoalexandre@ufscar.br
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RESUMO: ***Objetivo***: Estimar a prevalência e os fatores associados à sarcopenia, dinapenia e sarcodinapenia em idosos residentes no município de São Paulo. ***Métodos:*** Estudo transversal de base populacional envolvendo 1.168 idosos pertencentes à terceira onda do Estudo SABE (Saúde, Bem-Estar e Envelhecimento), em 2010. Foram considerados sarcopênicos os idosos com índice de massa muscular esquelética ≤ 8,90 kg/m² para homens e ≤ 6,37 kg/m² para mulheres, dinapênicos aqueles com força de preensão manual < 30 kg para homens e < 20 kg para mulheres, e sarcodinapênicos aqueles que apresentavam sarcopenia associada à dinapenia. Características sociodemográficas, comportamentais, condições clínicas, nutricionais e bioquímicas foram consideradas para determinar os fatores associados a cada uma das três condições por meio de regressão logística multinomial. ***Resultados:*** A prevalência de sarcopenia, dinapenia e sarcodinapenia foi, respectivamente, 4,8% (IC95% 3,6–6,3), 30,9% (IC95% 27,5–34,6) e 9,0% (IC95% 7,2–11,3). O avanço da idade e a desnutrição foram associados às três condições analisadas. O prejuízo cognitivo foi associado à dinapenia e à sarcodinapenia. A escolaridade, ter o hábito de fumar e não ter vida conjugal foram associados à sarcopenia, enquanto osteoartrite, escolaridade, ser ex-fumante e apresentar valores baixos de hemoglobina foram associados à dinapenia. Foram associados à sarcodinapenia o hábito de fumar e o risco de desnutrição. ***Conclusão:*** Dinapenia é a condição mais prevalente na população idosa, seguida pela sarcodinapenia e sarcopenia. Exceto por idade, escolaridade e desnutrição, os fatores associados à sarcopenia e à dinapenia são distintos. Entretanto, há similaridades em algumas associações quando se trata da presença de sarcodinapenia.

Palavras-chave: Sarcopenia. Dinapenia. Fraqueza Muscular. Músculo Esquelético. Idosos. Prevalência.

INTRODUCTION

Sarcopenia was originally defined as a decrease in muscle mass because of aging[1]. However, over the last decade, it has become a more comprehensive term regularly used to define the loss of muscle mass and strength related to aging[2,3].

Nevertheless, associating the changes in mass with the muscle strength and classifying them as sarcopenia implies accepting that there is a causal relationship, and that changes in muscle mass are directly and fully responsible for the changes in muscle strength[4,5].

Longitudinal studies involving muscle mass and strength have shown a much faster reduction in muscle strength compared with the muscle mass in the elderly, which suggest that the quality of the muscle may be compromised with aging, and building muscle mass cannot alone prevent the decline in muscle strength[6,7].

Moreover, it has become clear that sarcopenia alone is a poor predictor of functional decline and death, as opposed to the reduction in muscle strength, which has been associated with such outcomes in several studies[8,9].

In this context, Clark and Manini suggest that the term dynapenia should be used to describe the age-related reduction in muscle strength, dissociating the concept of mass reduction from the concept of muscle strength reduction, as adjustments in physiological function of the muscle in cellular, neural, and metabolic domains are capable of mediating the reduced strength associated with age, rather than only the decrease in muscle mass[4,5].

However, even acknowledging that perhaps the term dynapenia is more appropriate to represent decreased muscle strength, the consensus of the European Working Group on Sarcopenia in Older People (EWGSOP) suggests the diagnosis of sarcopenia based on the decrease in muscle mass, necessarily associated with the decrease in muscle strength or the decrease in physical performance. This may be due to their belief that sarcopenia is a well-known term and its replacement could generate major conceptual discussions in the scientific circles[10]. This concept has proved to be a good predictor of early disability and mortality[11,12].

However, recent research has suggested that the decrease in physical performance measured by the gait speed, which is a component of the sarcopenia construct of EWGSOP, is an outcome of the reduction in muscle mass and strength[13]. This brings up the need to analyze the prevalence of sarcopenia, dynapenia, and these two conditions combined: the sarcodynapenia, as well as its predictive factors for the incidence of decreased physical performance and death among the elderly.

Thus, the aim of this study was to estimate the prevalence and factors associated with sarcopenia, dynapenia, and sarcodynapenia in the community-dwelling elderly in São Paulo.

METHODS

This study is part of the SABE study (Health, Well-being, and Aging study). The complete methodology can be found in the first article of this supplement[(1)].

Data analyzed in this study are from three cohorts of the SABE study in 2010. Figure 1 shows the composition of the sample in each wave of the study.

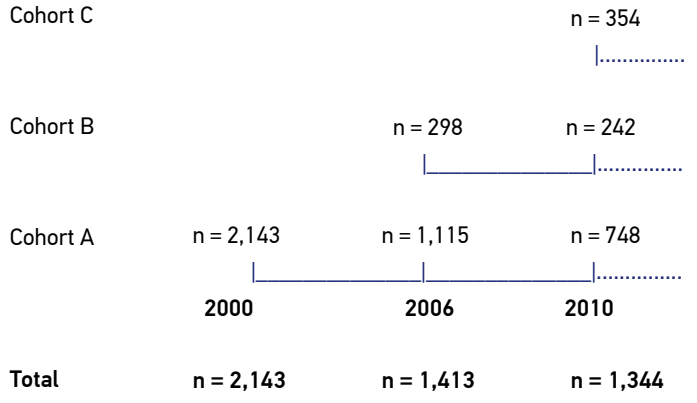

Figure 1. Composition of the sample of the SABE study in each of the three waves.

[(1)]Duarte YAO, Santos JLF, Silva NN. 10 Anos do Estudo SABE: antecedentes, metodologia e organização do estudo. Rev Bras Epidemiol. 2018; 21 Suppl 2: e180002.sup2. http://dx.doi.org/10.1590/1980-549720180002.supl.2

This study used all data from the three cohorts interviewed in 2010. Among the 1,344 respondents, 176 elderly were excluded because of lack of information on handgrip strength, weight, and height, which are the variables required to define sarcopenia and dynapenia. Thus, the final sample was composed of 1,168 individuals. These measures were not carried out on elderly incapable of performing the handgrip strength test or who were bedridden and therefore unable to remain standing for the measurement of weight and height. The excluded subjects were older, had higher income, lower prevalence of diabetes and uncontrolled glycated hemoglobin (HbA1c), greater cognitive impairment, and albumin deficit.

All participants signed an informed consent form and SABE study was approved by the Research Ethics Committee of the School of Public Health of the Universidade de São Paulo.

Muscle mass was determined by the appendicular skeletal muscle mass that was later adjusted by the height squared to create the skeletal muscle mass index. The cutoff point adopted to define sarcopenia was ≤ 6.37 kg/m² for women and ≤ 8.90 kg/m² for men. More information about the obtainment of appendicular skeletal muscle mass and cutoff points of skeletal muscle mass index is shown in another publication[14].

Muscle strength was assessed by grip strength in kilograms using a handgrip dynamometer (Takei Kiki Kogyo TK 1201, Tokyo, Japan). During the test, the participant was in a sitting position, with elbows and forearms resting on a table, and with the palm facing up. The participant was asked to grip the device using as much strength as possible. The apparatus was adjusted according to the size of the hands of each participant so that they could feel comfortable while testing. The test was performed twice in dominant hand, with 1-minute rest between each test. The higher value between the two trials was selected. The cutoff point adopted to represent dynapenia was < 30 kg for men and < 20 kg for women[11,12,14,15].

Elderly who had sarcopenia and dynapenia were considered sarcodynapenic, according to the criteria earlier described.

The sociodemographic characteristics included age, gender, marital status, income, and schooling. Age was grouped into three 10-year categories, with individuals aged 80 years or older grouped into one category. Marital status was classified as married (married or in a stable relationship) or single/not married (single, divorced, separated, or widowed). Income was classified into three categories in Brazilian monthly minimum wage (BRL 622.00): up to 2 minimum wages (≤ BRL 1,244.00), 2–5 minimum wages (> BRL 1,244.00 to ≤ BRL 3,110.00), and more than 5 minimum wages (> BRL 3,110.00). Schooling (in years) was analyzed as a discrete quantitative variable.

Participants were asked about their smoking habits, and they were classified as a smoker, ex-smoker, or nonsmoker. The weekly alcohol consumption was also investigated, and participants were classified into four categories: do not consume, consume once a week, consume 2–6 times a week, and consume every day. The level of physical activity was assessed using the Brazilian version of the International Physical Activity Questionnaire (IPAQ)[16]. The calculation of caloric expenditure was based on the metabolic equivalent (MET—energy cost of physical activity in question), the activities developed by the participants, the number of days per week that each activity was performed, the time spent to perform each activity, and

the individual body weight[17]. Men and women with caloric expenditure lower than 457.2 and 413.6 kcal (lowest quintile), respectively, were classified as having a sedentary lifestyle.

Health status was assessed by self-report of hypertension, diabetes, lung disease, heart disease, stroke, osteoarthritis, falls, and hospitalizations in the last 12 months. Cognition was assessed using a modified version of the Mini Mental State Examination (MMSE) because of the low level of education in the elderly population in Brazil. This version has 13 items that do not depend on schooling with a maximum possible score of 19 points[18]. Participants with a score lower than or equal to 12 were considered as having cognitive impairment[19]. Depression symptoms were assessed using the Geriatric Depression Scale[20,21]. Participants with a score greater than or equal to 6 were classified as presenting depression symptoms[22].

A trained interviewer measured the body weight using a calibrated scale with the individual being barefoot and wearing as little clothing as possible. Height was measured by a wall-mounted stadiometer.

The Mini Nutritional Assessment (MNA®) is a multidimensional and validated method, consisting of 18 questions grouped into four parts: anthropometry (body mass index, weight loss, and mid-upper arm and calf circumferences), clinical status (use of medications, mobility, skin lesions and pressure ulcers, lifestyle, psychological stress, or neuropsychological problems), dietary assessment (autonomy to feed, quality, and number of meals, and fluid intake), and self-perception of health and nutrition. The total score ranges from 0 to 30 points. Participants with scores from 17 to 23.5 points were considered at risk of malnutrition and those with scores lower than 17 points were considered undernourished; good nutritional status was defined as a score in MNA® higher than 23.5[23,24].

The biochemical parameters examined were hemoglobin, urea, creatinine, calcium, phosphorus, albumin, C-reactive protein (CRP), HbA1c, and fibrinogen. Blood samples were collected from participants after at least a 10-hour fasting time. Hemoglobin levels were analyzed in accordance with the reference ranges determined by the World Health Organization, with the levels considered low when < 12 mg/dL in women and < 13 mg/dL in men. Serum creatinine and urea were measured by enzymatic and colorimetric methods, respectively, and the values considered normal were 15–39 mg/dL for urea, and 0.6–1.0 mg/dL for creatinine.

The calcium was measured by a colorimetric method and analyzed as an ordinal categorical variable: ≥ 4.25 mEq/L ≤ 5.05 (normal); < 4.25 mEq/L (low) and > 5.05 mEq/L (high). Phosphorus was measured by phosphomolybdate method and a level lower than 2.5 mg/dL was classified as low. The albumin was measured by the colorimetric method and was considered low when lower than 3.4 g/dL. CRP was measured by high-sensitivity immunonephelometric assay, indicating inflammatory processes when higher than 5.0 mg/L. HbA1c was measured by the immunoturbidimetric method, indicating uncontrolled glycemia when higher than 6%. Fibrinogen was measured by the Clauss method and was considered increased when the level was higher than 400 mg/dL.

The prevalence of sarcopenia, dynapenia, and sarcodynapenia was estimated using a confidence interval (CI) of 95%. Multinomial logistic regression was adopted to analyze the factors associated with sarcopenia, dynapenia, and sarcodynapenia. Associations with

p-values ≤ 0.2 in the univariate analysis were selected for multiple regression analysis in which the stepwise forward method was applied.

Once the data are from complex sample, sample weights were considered in the analysis, which was performed by STATA 10® program (Stata Corp, College Station, TX).

RESULTS

The average age of the participants was 69.8 years (SD = 0.6). Among them, 60.4% were female, 55.8% were married, and the average schooling was 4.4 years (SD = 0.3). The most prevalent clinical condition was hypertension (66.8%), followed by osteoarthritis (32.4%), and diabetes (26.2%). Using the criteria of MNA®, 18.2% of the elderly were at risk of malnutrition and 1.6% were undernourished.

Among the evaluated participants, 7.5% presented low hemoglobin concentrations. There was a high prevalence of elderly with high serum concentrations of creatinine and urea (33.3 and 36.9%, respectively), and a low prevalence of calcium, phosphorus, and albumin deficiencies (10.1, 2.4, and 3.8%, respectively). Nearly a quarter of the sample presented elevated serum CRP levels and a fifth presented high levels of fibrinogen. HbA1c levels were considered above normal in 36.4% of the sample analyzed. Table 1 shows the characteristics of the participants.

Among the three conditions analyzed, dynapenia presented the highest prevalence (34.4% in women and 25.8% in men), followed by sarcodynapenia (10.4% in women and 6.9% in men), and sarcopenia (4.3% in women and 5.5% in men). The prevalence increased with age, but there was no statistically significant difference between genders of all age groups analyzed (Table 2).

Table 3 shows the results of multinomial logistic regression for sarcopenia, dynapenia, and sarcodynapenia. The relative risk ratio (RRR) and 95%CI of the final model for the factors associated with sarcopenia were 3.32 (95%CI 1.76 – 6.23) for those aged 70–79 years, 9.79 (95%CI 4.31 – 22.23) for those aged 80 years or older, 1.09 (95%CI 1.03 – 1.16) for each year of increase in schooling, 3.14 (95%CI 1.45 – 6.78) for smokers, 37.91 (95%CI 7.48 – 192.28) for undernourished (MNA® < 17), and 3.59 (95%CI 1.66 – 7.77) for those who were not married.

With regard to dynapenia, RRR and 95%CI were 1.99 (95%CI 1.44 – 2.76) for those aged 70–79 years, 6.13 (95%CI 3.71 – 10.11) for those aged 80 years or older, 4.69 (95%CI 2.84 – 7.74) for those with cognitive impairment (MMSE ≤ 12), 1.68 (95%CI 1.16 – 2.45) for those with osteoarthritis, 1.99 (95%CI 1.03 – 3.87) for those with low levels of hemoglobin, 0.95 (95%CI 0.91 – 0.98) for each year of increase in schooling, 0.64 (95%CI 0.47 – 0.89) for ex-smokers, and 2.63 (95%CI 1.04 – 6.64) for those undernourished (MNA® < 17).

Finally, with regard to sarcodynapenia, RRR and 95%CI were 11.51 (95%CI 4.65 – 28.47) for those aged 70–79 years, 78.98 (95%CI 30.26 – 206.13) for those aged 80 years or older, 3.99 (95%CI 1.90 – 8.36) for those with cognitive impairment (MMSE ≤ 12), 3.07 (95%CI 1.50 – 6.28) for smokers, 3.95 (95%CI 2.21 – 7.07) for those presenting risk of malnutrition according to MNA® (17 ≥ Man® ≤ 23.5), and 14.74 (95%CI 4.60 – 66, 33) for those undernourished (MNA® < 17).

Table 1. Characteristics of the 1,168 community-dwelling elderly in the city of São Paulo, Brazil (2010).

Sociodemographic variables	
Age	69.8 (SD = 0.6)
Gender (female)	60.4% (n = 752)
Marital status (married)	55.8% (n = 592)
Income	
> BRL 3,110.00	3.5% (n = 39)
> BRL 1,244.00 and ≤ BRL 3,110.00	14.0% (n = 175)
≤ BRL 1,244,00	82.2% (n = 953)
Not informed	0.3% (n = 1)
Schooling	4.4 (SD = 0.3)
Behavioral variables	
Smoking	
Nonsmoker	50.9% (n = 610)
Ex-smoker	36.8% (n = 430)
Smoker	12.2% (n = 127)
Not informed	0.1% (n = 1)
Weekly intake of alcohol	
Do not consume	68.3% (n = 829)
Consume once a week	19.2% (n = 219)
Consume 2–6 times a week	6.6% (n = 67)
Consume every day	5.9% (n = 53)
Sedentary lifestyle	36.1% (n = 435)
Clinical status	
Hypertension (yes)	66.8% (n = 789)
Diabetes (yes)	26.2% (n = 304)
Lung disease (yes)	9.5% (n = 111)
Heart disease (yes)	23.1% (n = 281)
Stroke (yes)	6.5% (n = 86)
Osteoarthritis (yes)	32.4% (n = 396)
Fall in the last 12 months (yes)	29.7% (n = 365)
Hospitalization in the last 12 months (yes)	10.6% (n = 124)
Mini Mental State Examination (≤ 12 points)	8.9% (n = 144)
Geriatric Depression Scale (≥ 6 points)	15.0% (n = 145)
Mini Nutritional Assessment – (17 ≥ MNA® ≤ 23.5)	18.2% (n = 238)
Mini Nutritional Assessment – (MNA® < 17 points)	1.6% (n = 20)
Biochemical analysis	
Hb < 12 mg/dL in women and < 13 mg/dL in men	7.5% (n = 102)
Urea ≥ 40 mg/dL	36.9% (n = 454)
Creatinine > 1.0 mg/dL	33.3% (n = 386)
Calcium < 4.25 mEq/L	10.1% (n = 106)
Calcium > 5.05 mEq/L	1.2% (n = 11)
Phosphorus < 2.5 mg/dL	2.4% (n = 29)
Albumin < 3.4 g/dL	3.8% (n = 54)
CRP > 5.0 mg/L	24.6% (n = 276)
HbA1c > 6.0%	36.4% (n = 409)
Fibrinogen > 400 mg/dL	20.2% (n = 244)

Data are presented as mean and standard deviation (SD), or number and percentage. Mean and proportions were calculated based on the sample weights. BRL: Brazilian reais; Hb: hemoglobin; CRP: C-reactive protein; HbA1c: glycated hemoglobin.

DISCUSSION

The aim of this study was to estimate the prevalence and factors associated with sarcopenia, dynapenia, and sarcodynapenia in the community-dwelling elderly in São Paulo, Brazil.

With regard to sarcopenia, prevalence was lower than that observed in previous studies. For example, Baumgartner et al.[25], using dual-energy X-ray absorptiometry (DEXA) and regression equations to measure and estimate the appendicular skeletal muscle mass (7.26 kg/m² for men and 5.45 kg/m² for women), found that the prevalence of sarcopenia ranged 13–24% in subjects aged less than 70 years, rising to approximately 50% in individuals aged 80 years or older. In another study, Newman et al.[26] found a prevalence of sarcopenia equal to 51.9% in women and 50.4% in men using DEXA to estimate the appendicular skeletal muscle mass and to calculate the appendicular skeletal muscle mass index (7.23 kg/m² for men and 5.67 kg/m² for women). The lower prevalence of

Table 2. Prevalence (%) and confidence interval (95%) of sarcopenia, dynapenia, and sarcodynapenia, by gender and age in community-dwelling elderly in the city of São Paulo, Brazil, 2010 (n = 1,168).

	Sarcopenia		Dynapenia		Sarcodynapenia	
	%	95%CI	%	95%CI	%	95%CI
Men (n = 416)	5.5 (n = 26)	(3.5 – 8.4)	25.8 (n = 127)	(21.9 – 30.1)	6.9 (n = 47)	(4.9 – 9.7)
60 – 69 years (n = 193)	2.8 (n = 7)	(1.3 – 5.9)	19.2 (n = 40)	(14.7 – 24.7)	1.2 (n = 2)	(0.3 – 4.5)
70 – 79 years (n = 113)	8.8 (n = 10)	(4.5 – 16.5)	30.7 (n = 38)	(22.8 – 39.9)	8.2 (n = 9)	(4.0 – 15.9)
80 years or older (n = 110)	10.2 (n = 9)	(5.6 – 17.9)	44.7 (n = 49)	(34.6 – 55.3)	31.1 (n = 36)	(21.5 – 42.6)
Women (n = 752)	4.3 (n = 33)	(3.0 – 6.0)	34.4 (n = 276)	(30.0 – 39.0)	10.4 (n = 101)	(8.0 – 13.3)
60 – 69 years (n = 340)	3.5 (n = 14)	(2.1 – 6.0)	26.6 (n = 92)	(21.0 – 33.2)	1.5 (n = 6)	(0.7 – 3.3)
70 – 79 years (n = 220)	5.2 (n = 11)	(2.5 – 10.7)	41.5 (n = 94)	(34.4 – 48.9)	13.6 (n = 28)	(9.7 – 18.8)
80 years or older (n = 192)	4.8 (n = 8)	(2.4 – 9.4)	46.1 (n = 90)	(39.2 – 53.1)	33.2 (n = 67)	(26.5 – 40.6)
Total (n = 1,168)	4.8 (n = 59)	(3.6 – 6.3)	30.9 (n = 403)	(27.5 – 34.6)	9.0 (n = 148)	(7.2 – 11.3)

The prevalence was calculated based on the sample weights; 95%CI: 95% Confidence Interval.

sarcopenia estimated in this study may be due to the decision of analyzing sarcodynapenia and sarcopenia separately, among other reasons. This reallocated the elderly with sarcopenia into two distinct groups.

We are not aware of any study that has estimated the prevalence of dynapenia and sarcodynapenia up to date. This gap is due to the lack of consensus in the standard definition of the term, definition of cutoff points, and the methods of measurement of easy execution in the comprehensive geriatric assessment. However, the decision to estimate such prevalence in this study is due to the fact that dynapenia and sarcopenia were successfully tested in longitudinal studies as predictors of disability and death in the elderly population living in São Paulo[11,12,14].

Table 3. Multinomial logistic regression final model for sarcopenia, dynapenia, and sarcodynapenia in community-dwelling elderly in the city of São Paulo, Brazil, 2010 (n = 1,168).

Variables	Sarcopenia		Dynapenia		Sarcodynapenia	
	RRR	95%CI	RRR	95%CI	RRR	95%CI
Age (60 – 69 years)	1.00		1.00		1.00	
Age (70 – 79 years)	3.32	(1.76 – 6.23)	1.99	(1.44 – 2.76)	11.51	(4.65 – 28.47)
Age (80 years or older)	9.79	(4.31 – 22.23)	6.13	(3.71 – 10.11)	78.98	(30.26 – 206.13)
Mini Mental State Examination (≥ 13 points)	1.00		1.00		1.00	
Mini Mental State Examination (≤ 12 points)	1.40	(0.40 – 4.92)	4.69	(2.84 – 7.74)	3.99	(1.90 – 8.36)
Osteoarthritis (no)	1.00		1.00		1.00	
Osteoarthritis (yes)	0.84	(0.40 – 1.84)	1.68	(1.16 – 2.45)	0.95	(0.59 – 1.53)
Hb ≥ 12 mg/dL in women and ≥ 13 mg/dL in men	1.00		1.00		1.00	
Hb < 12 mg/dL in women and < 13 mg/dL in men	1.67	(0.63 – 4.43)	1.99	(1.03 – 3.87)	1.51	(0.66 – 3.44)
Schooling (years)	1.09	(1.03 – 1.16)	0.95	(0.91 – 0.98)	0.98	(0.91 – 1.05)
Non-smoker	1.00		1.00		1.00	
Ex-smoker	0.84	(0.41 – 1.73)	0.64	(0.47 – 0.89)	0.69	(0.41 – 1.17)
Smoker	3.14	(1.45 – 6.78)	1.11	(0.62 – 1.97)	3.07	(1.50 – 6.28)
Good nutritional status (MNA® > 23.5)	1.00		1.00		1.00	
At risk of malnutrition (17 ≥ MNA® ≤ 23.5)	2.04	(0.89 – 4.92)	1.15	(0.75 – 1.78)	3.95	(2.21 – 7.07)
Undernourished (MNA® < 17)	37.91	(7.48 – 192.28)	2.63	(1.04 – 6.64)	14.74	(4.60 – 66.33)
Married	1.00		1.00		1.00	
Not married	3.59	(1.66 – 7.77)	0.93	(0.65 – 1.33)	1.31	(0.69 – 2.50)

Model adjusted by gender, heart disease, and presence of falls; Hb: hemoglobin; RRR: Relative Risk Ratio; 95%CI: 95% Confidence Interval; MNA: Mini Nutritional Assessment.

According to previous studies, we investigated a comprehensive set of sociodemographic, behavioral, clinical, and biochemical conditions that would be involved in the pathogenesis of sarcopenia, and thus would be associated with dynapenia and sarcodynapenia. Several mechanisms may indeed be involved in the onset and progression of such events such as aging process, malnutrition, sedentary lifestyle, smoking, prolonged bed rest, chronic diseases, endocrine disorders, and inflammatory diseases[13].

Among all the variables that were representatives of these mechanisms, we found that advancing age with a dose-response effect and malnutrition were factors associated with the three conditions analyzed. Cognitive impairment was associated with dynapenia and sarcodynapenia. Schooling (in inverse association), smoking, and not having a marital life were associated with sarcopenia, whereas osteoarthritis, education, being an ex-smoker, and presenting low hemoglobin levels were associated with dynapenia. Smoking and the risk of malnutrition were associated with sarcodynapenia.

Malnutrition and the risk of malnutrition are, in different proportions, energy and protein deficiencies capable of causing adverse effects on body composition[27]. The absence of suitable nutritional support activates the immune system and increases the synthesis of inflammatory cytokines capable of amplifying the chronic catabolic conditions, reducing muscle mass and, consequently, affecting their functions[28]. This condition explains its association with sarcopenia, dynapenia, and sarcodynapenia.

Elderly who were not married were more likely to present sarcopenia. Factors such as low income, low education, and loneliness have been associated with low food availability, which increase malnutrition or the risk of malnutrition, consequently, increasing the risk of sarcopenia[27].

Cognitive impairment clearly reinforces and emphasizes the neural changes that occur in the central nervous system, which, directly or indirectly, affect neuromuscular system. Such changes affect and modify levels and activity of neurotransmitter agents, reducing the number of motor units and their ability to maintain muscle activation. In addition to this, peripheral changes caused by alterations in the neuromuscular junction and muscle tissue affect even further the functioning of the neuromuscular system, compromising the ability of the muscles to generate force and resistance[29], and probably resulting in dynapenia and sarcodynapenia.

Smoking has been associated with sarcopenia[14,26,30], because it may compromise the ability of the muscular system to obtain energy because of different factors such as reduced blood flow to the muscle during rest and during certain types of contractions, inability of the circulatory and muscular systems to remove metabolic waste products, and insufficient supply of energy and oxygen to different metabolic pathways[31,32]. Thus, smoking combined with aging-related changes in the neuromuscular system increases muscle fatigue and, consequently, protein catabolism, which may reduce the muscle mass and strength. However, in this analysis, smoking cessation reduced the chance to present dynapenia in 36%, which is a fact that deserves further investigation, as it can be attributed to neuromuscular alterations

that occur after smoking cessation, or simply to the fact that in sample analyzed, ex-smokers presented higher neuromuscular strength.

In this analysis, low hemoglobin levels, which indicate anemia, were associated with dynapenia, but not with sarcopenia and sarcodynapenia. Previous studies have demonstrated that the hemoglobin levels are associated with changes in muscle mass and fat, and anemia can affect the physical performance by different means, typically involving decreased tissue oxygenation[33]. That would be a plausible explanation for the association found between anemia, low oxygen, and dynapenia. However, the absence of an association between low levels of hemoglobin and sarcopenia and sarcodynapenia may suggest that physiological mechanisms involved in the strength reduction would be distinct from those involved in the reduction of muscle mass and strength linked to the muscle mass.

Osteoarthritis is the only self-reported disease, which was associated with dynapenia. It is known that this chronic disease limits mobility because of pain and stiffness. There is evidence from the longitudinal studies showing that those individuals who present joint diseases have reduced strength mediated by increased limitation of activities[34], which would explain the association between osteoarthritis and dynapenia.

This study has some limitations. First, the analysis is cross-sectional, and therefore it is not possible to establish a mechanism of cause and effect between the associations. Second, the SABE study is focused on the community-dwelling population and does not include those residents in long-stay institutions. Thus, the estimated prevalence may have some degree of bias, because institutionalized elderly may have a higher prevalence of sarcopenia, dynapenia, and sarcodynapenia. However, the institutionalized elderly population in Brazil and in São Paulo is still relatively low, which minimizes this bias. Third, the population excluded from the analysis was older, had higher income, lower prevalence of diabetes and uncontrolled HbA1c, greater cognitive impairment, and albumin deficit, which could lead to the underestimation of the prevalence found, because some of these factors were associated with the conditions analyzed.

This study has some strengths. First, the study was conducted in a large sample of the community-dwelling elderly that represents the resident population in the city of São Paulo. Second, as far as we are aware, this is the first study that estimated the prevalence of dynapenia and sarcodynapenia in a community-dwelling elderly population.

CONCLUSION

The most prevalent condition in the elderly population is dynapenia, followed by sarcodynapenia, and, finally, sarcopenia. Except for age, schooling, and malnutrition, factors associated with sarcopenia and dynapenia are distinct. However, there are similarities in some associations when related to the occurrence of sarcodynapenia.

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