Epidemiology

Prevalence and factors associated with dynapenia in older women using different diagnostic criteria

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Abstract - Aim: This study aimed to identify the prevalence and factors associated with dynapenia in older women, considering different cutoff points as diagnostic criteria. **Methods:** This epidemiological study was conducted with 205 older women (72.7 ± 7.1 years). Dynapenia was diagnosed using the handgrip strength test (HGS) using two cutoff points (< 16 or < 20 kgf). Socio-demographic, behavioral, and health status information was obtained from a specific form; nutritional status was assessed by body mass index, and the International Physical Activity Questionnaire identified the level of physical activity. **Results:** The prevalence of dynapenia was 14.1% (HGS < 16 kgf) and 46.3% (HGS < 20 kgf) ($p < 0.001$). It was also observed that older women with family income ≤ 1 minimum wage and those with low weight presented, respectively, 2.22 (95%CI: 1.12-4.39) and 4.72 (95%CI: 1.64-13.58) times higher probability of dynapenia identified by HGS < 16 kgf. Moreover, for the cutoff point < 20 kgf, the probability of dynapenia was higher in women aged ≥ 80 years (PR:1.91; 95%CI: 1.23-2.95), in insufficiently active women (PR: 1.34; 95%CI: 1.01-2.57), among those with low weight (PR: 1.61; 95%CI: 1.01-2.57), and in those who reported falls (PR:1.42; 95%CI: 1.04-1.96). **Conclusion:** Therefore, it is concluded that there is a difference between the prevalence and factors associated with dynapenia when different cutoff points are adopted.

Keywords: epidemiology, muscle strength, post-menopause.

Introduction

The aging process is associated with physiological modifications in all body systems[1]. This means that structural adaptations and/or muscle function can directly impact the functional capacity of older adults at the level of the musculoskeletal system[2,3].

Senescence affects the female musculoskeletal system more negatively as ovarian aging causes hormonal changes. Thus, reduced production of sex hormones such as estrogen, which is responsible for the quality and quantity of muscle, contributes to muscle weakness[4].

The decrease in muscle strength with advancing age configures dynapenia[5]. This condition, in turn, brings with it adverse repercussions on the health of older adults, as it is an important predictor of functional disability, reduced mobility[6], mortality[7], frailty syndrome[8], risk of falling[9], sarcopenia[6], cognitive impairment[10], and depressive symptoms[11].

Among the different criteria for the diagnosis of dynapenia is the handgrip strength test, in which muscle strength is measured utilizing a hydraulic dynamometer[6]. It is an easily implementable and inexpensive evaluation method[12], which has a good relationship with overall muscle strength because it is associated with the strength of other muscle groups[13].

Also concerning the diagnosis of dynapenia, some of the most used cutoff points are those proposed by Lauretani et al.[14] and by Dodds et al.[15], which were recommended by the European Working Group on Sarcopenia in Older People in 2010[16] and 2019[6] to screen older adults with muscle weakness. A literature search, however, did not reveal any studies that explored factors associated with dynapenia according to these different cutoff points.

It is expected to find a higher prevalence of dynapenia when more comprehensive cutoff points are adopted as diagnostic criteria, however, more precise identification of the factors associated with this outcome is necessary, according to the normative value used, among the population groups more vulnerable to said morbidity. This information can help health professionals in the screening of women with a higher probability of being dynapenic, thus

enabling the maintenance or recovery of the level of muscle strength in the respective population. Thus, the objective of this study was to identify the prevalence and factors associated with dynapenia in older women, considering different cutoff points as diagnostic criteria.

Methods

Study design, location, and participants

This is an epidemiological study, with a cross-sectional design, conducted with older women (60 years or older) from the *Associação de Amigos, Grupos de Convivência e Universidade Aberta com a Terceira Idade* (*AAGRUTI*) in Jequié-BA[17].

According to information provided by the AAGRUTI coordination, in 2017, there were 11 active coexistence groups, in which 280 middle-aged and older women participated. Despite this, two women (0.8%) were not found after three visits made, on different days, to the meetings of their respective coexistence groups. Therefore, thirty-eight women under the age of 60 were excluded from the study based on the established eligibility criteria. A Mini-Mental State Examination (MMSE) identified 32 women as having cognitive deficits, which excluded them from the study[18], with a cutoff point of 12 points, and three for not having information regarding the measurement of handgrip strength (Figure 1).

Thus, of the 280 older women who were part of the target population of the study, only 205 were enrolled in the research. The final sample size was considered larger than necessary for a good representation of the population studied (n = 163) based on sample calculation performed with a confidence level of 95% and a sample error of 5%[17].

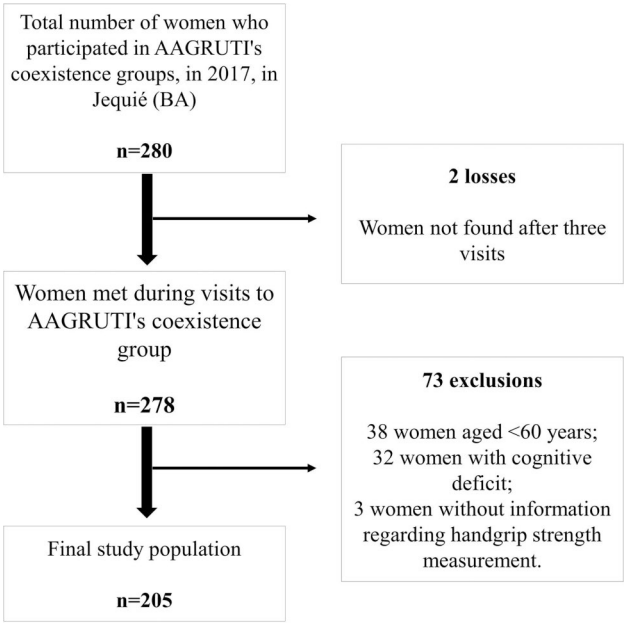

Figure 1 - Decision diagram in the selection process of the women who participated in the study. Jequié-BA, Brazil, 2017.

Data collection

Data was collected between July and September 2017, in a single step, at the location where the coexistence groups of AAGRUTI operate. Initially, interviews were conducted to identify sociodemographic information, using a form based on the one used by the *Saúde, Bem-Estar e Envelhecimento* (*SABE*)[19] survey. After the interviews, the older women were directed to a room reserved for anthropometric and handgrip strength measurements.

Dynapenia (dependent variable)

For the diagnosis of dynapenia, we used the handgrip strength values of the dominant upper limb, measured employing a hand-held hydraulic dynamometer (Saehan Corporation SH5001®, Korea).

During the test, the participants were instructed to remain comfortably seated, with the elbow flexed at 90° and supported on a table, the forearm in a neutral position, and the wrist varying from 0° to 30° of extension. In addition, the dynamometer was adjusted according to the grip of each older woman, so that the handle was in contact with the middle phalanges of the fingers, and they were also encouraged to press the dynamometer handle as hard as possible[20].

Two attempts were made, maintaining a one-minute interval between them, and for the statistical analysis, the highest value in kilogram-force (kgf) was considered. Finally, two different cutoff points were adopted to diagnose dynapenia, in order to observe the behavior of the independent variables concerning the outcome.

Thus, in the first moment of the statistical analysis, the women who presented HGS < 16 kgf[6,15] were considered dynapenic. While in a second moment the data analysis was performed considering the cutoff point for the diagnosis of dynapenia HGS < 20 kgf[14,16].

Independent variables

Socio-demographic

Age group (60-69 years; 70-79 years; ≥ 80 years); marital status (married/stable union; single/divorced; widowed); knowing how to read and write an errand (yes; no); family income, categorized as ≤ 1 minimum wage and > 1 minimum wage (minimum wage in 2017 = R$937.00).

Behavioral

Ingestion of alcoholic beverages in the last three months (did not drink; ≥ 1 day/week); smoking (smoker; ex-smoker; never smoked); level of physical activity, assessed by the International Physical Activity Question-

naire[21], validated for older Brazilian women[22]. Women who had weekly time spent on physical activity < 150 min were considered insufficiently active[23].

Health conditions

Previous diagnosis of hypertension, diabetes mellitus or osteoporosis (no; yes); occurrence of falls in the last 12 months (no; yes); polypharmacy (no; yes), considered as the continuous use of three or more medications[24]; self-perception of health (excellent/very good/good; regular; poor); and nutritional status, measured by body mass index [BMI = (body mass / (height^2))], which was categorized according to the recommendations of the Brazilian Society of Parenteral and Enteral Nutrition[25] as follows: underweight = BMI < 22.0 kg/m^2; eutrophy = BMI between 22.0 and 27.0 kg/m^2; overweight/obesity = BMI > 27.0 kg/m^2.

Statistical analysis

The descriptive analyses were performed using absolute and relative frequencies, mean, and standard deviation. Initially, McNemar's test was used to determine the prevalence of dynapenia according to the different cut-off points for the inferential analysis. Based on the bivariate association analysis, Poisson regression with robust variance was used to calculate the Prevalence Ratios and their respective 95% Confidence Intervals.

The variables that demonstrated a significant level of at least 20% ($p \leq 0.20$) were considered for insertion into the multivariate analysis in a hierarchical model, where socio-demographic aspects constituted the most distal level (Level 1), behavioral aspects constituted the intermediate level (Level 2), and health conditions, the most proximal level (Level 3), as presented in Figure 2.

The effect of each independent variable was controlled by the variables of the same and previous levels. Thus, only the variables that presented a value of $p \leq 0.20$, verified by Wald's test for heterogeneity, remained in the final model. The significance level adopted for the identification of factors associated with dynapenia was 5,0%. Data analyses were performed using the Statistical Package for Social Sciences (SPSS 21.0, Inc, Chicago, IL).

Ethical aspects

This study was conducted according to the Helsinki Declaration of the World Medical Association, being in accordance with the determination of Resolution No. 466/2012 of the Brazilian National Health Council, being thus approved by the Research Ethics Committee of the State University of Southwest Bahia (*UESB*), under opinion No. 2.073.844/2017.

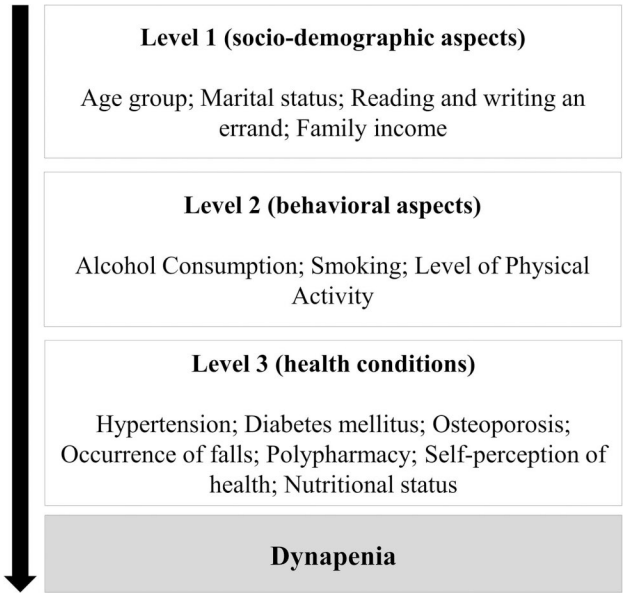

Figure 2 - The hierarchical model was used to identify factors associated with dynapenia in older women. Jequié-BA, Brazil, 2017.

Result

The study was conducted with 205 older women, with a mean age of 72.7 ± 7.1 years. It was also verified that 53.1% of the older women belonged to the age group 70-79 years old, 50.2% were widows, 29.3% were classified as insufficiently active and 77.1% had arterial hypertension. Other characteristics of the study population can be seen in Table 1.

Figure 3 shows the prevalence of dynapenia verified by different cutoff points of the HGS strength, which were significantly different, with the highest value for HGS < 20 kgf ($p < 0.001$).

Table 2 shows the prevalence of dynapenia (HGS < 16 kgf and HGS < 20 kgf) in older women according to the independent variables. From the bivariate analyses, it was verified that family income, nutritional status, diabetes mellitus, polypharmacy, the occurrence of falls, and self-perception of health presented a significance level ≤ 20.0% for HGS < 16 kgf, being included in the multivariate analysis.

As for the dynapenia identified from the HGS < 20 kgf, the variables that demonstrated significance level ≤ 20.0% and participated in the multivariate analysis were: age group, family income, level of physical activity, alcohol intake, nutritional status, diabetes mellitus, and occurrence of falls.

After the intra- and inter-level adjustments in the multivariate analysis for HGS < 16 kgf, it was found that the variables self-perception of health and occurrence of falls showed a significance level of $p > 0.20$, and were therefore removed from the model. Thus, older women with family income ≤1 minimum wage (PR: 2.22; 95%CI:

Table 1 - Descriptive analysis of socio-demographic, behavioral, and health condition characteristics of the 205 older women participating in the study. Jequié-BA, Brazil, 2017.

Variables	% answer	n = 205	%
Age group	100.0		
60-69 years		61	29.8
70-79 years		109	53.1
≥ 80 years		35	17.1
Marital status	99.0		
Married/stable union		59	29.1
Single/divorced		42	20.7
Widow		102	50.2
Read and write a note	99.0		
Yes		159	78.3
No		44	21.7
Family income	97.1		
≤ 1 minimum wage		131	65.8
> 1 minimum wage		68	34.2
Level of physical activity	93.2		
Sufficient		135	70.7
Insufficient		56	29.3
Smoking	99.0		
Never smoked		149	73.4
Ex-smoker		49	24.1
Smoker		5	2.5
Alcohol Ingestion	99.5		
Does not drink		150	73.5
≥ 1 day per week		54	26.5
Nutritional status	99.5		
Low weight		78	38.2
Eutrophic		22	10.8
Overweight/obesity		104	51.0
Arterial hypertension	100.0		
No		47	22.9
Yes		158	77.1
Diabetes melittus	99.9		
No		146	71.9
Yes		57	28.1
Osteoporosis	98.0		
No		137	68.2
Yes		64	31.8
Polypharmacy	88.8		
No		84	46.2
Yes		98	53.8
Occurrence of falls	99.0		
No		147	72.4
Yes		56	27.6
Self-perception of health	100.0		
Excellent/very good/good		71	34.6
Regular		107	52.2
Bad		27	13.2

n: number of participants; %: percentage.

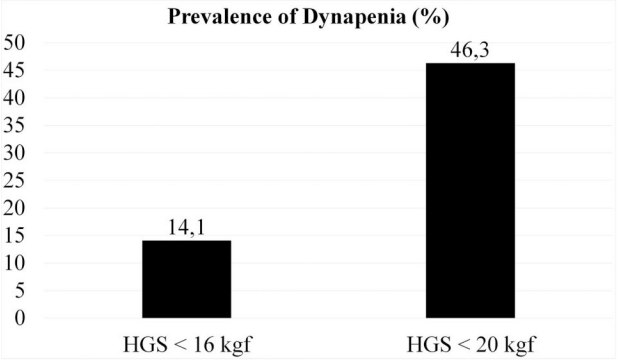

Figure 3 - Prevalences of dynapenia were identified by different cutoff points in older women. Jequié-BA, Brazil, 2017.

1.12-4.39) and those with low weight (PR: 4.72; 95%CI: 1.64-13.58) were associated with dynapenia, identified through the respective cutoff point.

As for the HGS cutoff point < 20 kgf, the variable alcohol intake did not remain in the multivariate analysis model because it had a significance level of p > 0.20. Thus, older women aged 80 years or older (PR: 1.91; 95% CI: 1.23-2.95), those who were insufficiently active (PR: 1.34; 95%CI: 1.01-2.57), those who were underweight (PR: 1.61; 95%CI: 1.01-2.57), and those who reported falls in the 12 months before data collection (PR: 1.42; 95%CI: 1.04-1.96) were associated with dynapenia (Table 3).

Discussion

This study identified the prevalence and factors associated with dynapenia in older women, considering different cutoff points as diagnostic criteria. Corroborating the hypothesis presented in the previous topic, it was observed that the prevalence of the outcome varied when different HGS reference values were adopted, with a higher frequency identified when using the cutoff point < 20 kgf as a criterion to characterize muscle weakness.

Alexandre et al.[26] verified in a study with 1,168 older adult individuals (60.4% women), conducted in São Paulo-SP, a prevalence of dynapenia of 34.4% in females (HGS < 20 kgf). In the study by Borges et al.[27], conducted with 8,396 Brazilian adults aged 50 years or older (53.3% women), in which the cutoff point adopted to identify dynapenia in women was < 16 kgf, the prevalence observed was 27.5% among those aged ≥ 65 years.

The prevalence of dynapenia evidenced in this study, verified for each of the established cutoff points, differ from the results obtained by the abovementioned authors. Such discrepancies may be justified by variations in aspects such as the socio-demographic profile and health conditions of the participants in each study. Nevertheless, it was observed that a higher prevalence was found for all cases when an HGS < 20 kgf was considered as a diag-

Table 2 - Bivariate analysis between the prevalence of dynapenia by different criteria (HGS < 16 kgf and HGS < 20 kgf) and the independent variables of the study. Jequié-BA, Brazil, 2017.

Variables	Dynapenia < 16 kgf		Dynapenia < 20 kgf	
	Prevalence (%)	Gross PR (95%CI)	Prevalence (%)	Gross PR (95%CI)
Age group				*
60-69 years	11.5	1	34.4	1
70-79 years	12.8	1.11 (0.79-5.0)	45.9	1.33 (0.89-1.99)
≥ 80 years	22.9	1.99 (0.47-2.62)	68.6	1.99 (1.31-3.00)
Marital status				
Married/stable union	8.5	1	44.1	1
Single/divorced	16.7	1.96 (0.67-5.77)	42.9	0.97(0.61-1.54)
Widow	15.7	1.85 (0.71-4.79)	48.0	1.09 (0.61-1.52)
Read and write a note				
Yes	13.8	1	47.2	1
No	11.4	0.82 (0.33-2.04)	40.9	0.86 (0.58-1.28)
Family income		*		*
≤ 1 minimum wage	22.1	2.22 (1.12-4.39)	41.2	1.32 (0.97-1.77)
> 1 minimum wage	9.9	1	54.4	1
Level of physical activity				*
Sufficient	13.3	1	41.5	1
Insufficient	19.6	1.47 (0.74-2.91)	58.9	1.42 (1.05-1.91)
Smoking				
Never smoked	16.1	1	48.3	1
Ex-smoker	10.2	0.63 (0.25-1.57)	42.9	0.88 (0.61-1.27)
Smoker	-	-	20.9	0.41 (0.01-2.40)
Alcohol Ingestion				*
Does not drink	16.0	1	50.0	1
≥ 1 day per week	9.3	0.57 (0.23-1.44)	70.0	0.74 (0.50-1.08)
Nutritional status		*		*
Low weight	27.3	3.54 (1.26-9.91)	68.2	1.61 (1.09-2.37)
Eutrophic	7.7	1	42.3	1
Overweight/obesity	16.3	2.12 (0.87-5.14)	44.2	1.04 (0.74-1.46)
Arterial hypertension				
No	14.9	1	51.0	1
Yes	13.9	0.93 (0.42-2.05)	44.9	0.88 (0.63-1.22)
Diabetes melittus		*		*
No	11.0	1	43.2	1
Yes	22.8	2.08 (1.07-4.04)	56.1	1.30 (0.96-1.74)
Osteoporosis				
No	13.1	1	45.3	1
Yes	17.2	1.30 (0.65-2.60)	50.0	1.10 (0.81-1.50)
Polypharmacy		*		
No	9.5	1	44.0	1
Yes	19.4	2.03 (0.94-4.41)	49.0	1.11 (0.81-1.52)
Occurrence of falls		*		*
No	10.2	1	40.8	1
Yes	23.2	2.27 (1.15-4.47)	60.7	1.48 (1.11-1.98)
Self-perception of health		*		
Excellent/very good/good	8.5	1	46.3	1
Regular	15.9	1.88 (0.77-4.53)	44.9	0.96 (0.69-1.33)
Bad	22.2	2.63 (0.92-7.44)	51.9	1.11 (0.71-1.73)

PR: prevalence ratio; CI: confidence interval; *p value ≤ 0.20.

Table 3 - Final hierarchical model of the association between dynapenia (HGS < 16 kgf and HGS < 20 kgf) and the independent variables in the study population. Jequié-BA, Brazil, 2017.

Variables	Dynapenia < 16 kgf	Dynapenia < 20 kgf
	Adjusted PR (95%CI)	Adjusted PR (95%CI)
Age group		*
60-69 years	-	1
70-79 years	-	1.39 (0.92-2.09)
≥ 80 years	-	1.91 (1.23-2.95)
Family income	*	
> 1 minimum wage	1	1
≤ 1 minimum wage	2.22 (1.12-4.39)	1.24 (0.92-1.68)
Level of physical activity		*
Sufficient	-	1
Insufficient	-	1.34 (1.01-1.80)
Nutritional status	*	*
Low weight	4.72 (1.64-13.58)	1.61 (1.01-2.57)
Eutrophic	1	1
Overweight/obesity	1.84 (0.73-4.59)	0.97 (0.68-1.37)
Diabetes Mellitus		
No	1	1
Yes	1.67 (0.83-3.336)	1.28 (0.93-1.75)
Polypharmacy		
No	1	-
Yes	2.16 (0.94-4.98)	-
Occurrence of falls		*
No	-	1
Yes	-	1.42 (1.04-1.96)

PR: prevalence ratio; CI: confidence interval; *p value ≤ 0.05.

nostic criterion. From this evidence, it is observed that the cutoff point adopted impacts the prevalence of the outcome. Given this information, it is possible to reflect that using higher cutoff points for HGS can help in the screening of a larger contingent of older women who already present muscular strength impairment, propitiating early intervention in clinical practice.

This study also evidenced that having a family income equal to or less than one minimum wage was a factor associated with dynapenia defined by HGS < 16 kgf. The relationship between the socioeconomic status of older adults and grip strength has also been evidenced by other authors[28]. Furthermore, it is possible to verify in the literature evidence pointing to a relationship between healthy eating patterns and HGS[29]. Corroborating these findings, a time-series study covering the period from 2016 to 2019 showed that low-income women were more exposed to adverse health conditions, such as smoking, obesity, lower levels of physical activity, and worse eating habits, in addition to having worse access to health services[30].

The aspects mentioned above incite the reflection that a low family income may imply in eating habits, making it impossible to have a rich and varied intake of nutrients, which is insufficient to meet the body's needs. Thus, it is worth reflecting that public policies are needed in order to reduce the proportion of older women with family income below one minimum wage, aiming to provide conditions for a regular and balanced diet.

The association between low weight and dynapenia was ascertained in this study for the two proposed cutoff points (HGS < 16 and < 20 kgf). A study was carried out with older adults (≥ 60 years) in Rio Branco-AC, where muscle weakness was defined by the 20th percentile of HGS, stratified by sex and age group (women = 60-69 years: 18.70 kgf; 70-79 years; 16.10 kgf; ≥ 80 years: 12.00 kgf), showed higher chances of dynapenia among older women with low weight (women = OR: 2.61; 95% CI: 1.46-4.66)[31]. A similar result was identified among older adults residents in Belo Horizonte, Barueri, and Santa Cruz, where low weight was twice as likely to be associated with dynapenia (OR: 2.10; 95% CI: 1.23-3.57), defined by a cutoff point of HGS ≤ 17.4 kgf for women[32].

Despite the methodological differences between the studies cited above, the results presented raise the discussion that low weight may be related to malnutrition, marked by low muscle mass contingents. This condition favors the release of inflammatory cytokines, which result in a severe catabolic state, impacting negatively on the level of muscle strength[26,33].

In line with the results obtained, Alexandre et al.[26] found that the older adults in the age groups 70-79 years and ≥ 80 years presented, respectively, 1.99 (95%CI: 1.44-2.76) and 6.13 (95%CI: 3.71-10.11) times higher probability of dynapenia in relation to those aged between 60 and 69 years. In a sample of 598 older adults of both sexes from Florianópolis-SC, where dynapenia was defined as the first quartile of HGS, stratified by BMI (women = underweight: ≤ 15.00 kgf; eutrophy: ≤ 12.50 kgf; overweight / obesity: ≤ 14.40 kgf), it was observed that among older women, the odds to dynapenia were in the order of 2.28 times (95%CI: 1.12-5.07) and 3.68 (95%CI: 1.35-10.00) higher for those assessed from the age groups of 70-79 years and ≥ 80 years, respectively, when compared to the younger age group (60-69 years)[34].

Functional performance is regulated by several factors, among them those related to the nervous, muscular, and skeletal systems. Thus, the degeneration of anatomical and/or physiological processes that govern these systems, such as a decrease in the excitatory stimuli of muscle cells; a decline in the recruitment capacity of motor units; and the number and cross-sectional areas of muscle fibers, result in losses to muscle fitness and become more severe as age advances[35].

Our findings indicated that insufficiently active older women were more likely to be dynapenic (HGS < 20 kgf).

Among Korean older women participating in a study that used HGS < 16.8 kgf for women as a cutoff point, it was found that those with a sufficient level of physical activity showed a lower chance of dynapenia (OR: 0.60; 95% CI: 0.43-0.83)[36]. Corroborating with these findings, Confortin et al.[34] found that sufficiently active older women presented 55.0% (95%CI: 0.25-0.82) less chance of being dynapenic when compared to insufficiently active women. These inverse associations between the level of physical activity and dynapenia are probably a consequence of the positive repercussions of exercise, such as improved communication between the nervous and muscular systems, promotion of increased satellite cells, and attenuation of anabolic resistance[37].

Another factor associated with dynapenia was the occurrence of falls in the last 12 months. Lenardt et al.[38], when evaluating 203 older adults subjects (60.59% women), they verified that dynapenia, identified by the cutoff point of HGS < 16 kgf for older women, was more prevalent among those who reported falling (20.2%) in relation to those who did not fall (9.8%) ($p < 0.001$). Results evidenced in a study conducted with 1,067 older adults (58.9% women) from Taiwan showed that the HGS was lower in the group of older adults fallers (17.6 ± 8.0 kgf) when compared to the group without this occurrence (20.7 ± 8.7 kgf) ($p < 0.001$)[39]. The relationship between muscle strength and falls is bilateral, i.e., older adults can fall because they have muscle weakness or lose strength because they fall and have their mobility reduced. Thus, besides being a risk factor for muscle weakness, the occurrence of falls can also be a consequence of dynapenia[40].

Among the limitations of this study, it is possible to mention the cross-sectional design, which does not allow for establishing a causal relationship between dynapenia and the independent variables of the study, and the fact that some variables were self-reported, which may negatively affect, for example, the measurement of time spent on habitual physical activity or the forgetfulness of information on the diagnosis of some morbidity. It should be noted, however, that the MMSE is used in order to minimize the possibility of memory bias, as old women with cognitive impairment are excluded from the study.

However, the gold standard method used to measure muscle strength and the verification of the outcome through two cutoff points stands out as a strong point, something new in studies that sought to verify these associations. Therefore, it is believed that knowing the impacts of using different cutoff points to determine the prevalence and factors associated with dynapenia in older women may contribute to a more accurate assessment of the health status of this population group, considering that this outcome is a relevant marker of morbidity and mortality. Thus, these aspects can guide the decision-making of health professionals and managers, in the context of primary care, when implementing interventions aimed more specifically at the identified associated factors.

Conclusions

A high prevalence of dynapenia was identified among the older women evaluated for both cutoff points adopted for HGS. Furthermore, as expected, a greater amount of older adults were diagnosed as dynapenic when < 20 kgf was used to define muscle weakness. This study also showed that family income lower than one minimum wage and low weight were associated with dynapenia diagnosed through HGS < 16 kgf and that the older women aged ≥ 80 years, those who were insufficiently active, those with low weight, and those who reported falls were associated with dynapenia with a cutoff point for HGS < 20 kgf.

Therefore, it is necessary to implement public health policies, specific for the older adult population, considering the access to health education programs and adequate social support that provide conditions for both physical exercise and balanced nutrition, expanding the vision of primary health care on this outcome.

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