Low muscle reserve in older adults and associated factors

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Abstract

Objective: To estimate the prevalence of low muscle reserve and identify associated factors in older people. *Method*: Cross-sectional study carried out with 784 non-institutionalized older people (60 years or older), living in Viçosa, Minas Gerais, in 2009. The characteristics of interest were sociodemographic, life habits, health and anthropometric conditions. Low muscle reserve (LMR) was defined as leg circumference (LC) < 33 cm for women and < 34 cm for men. Descriptive analysis, bivariate and multiple analysis were performed, using Poisson regression with robust variance, to identify the factors independently associated with the outcome of interest. *Results:* More than half of the sample consisted of women (52.9%), more frequently younger seniors (60 – 69 years old :49.5%), with a maximum of four years of study (79.9%). The prevalence of low muscle reserve was 21.7% (95%CI 18.9%-24.7%) and the independently associated factors were the age group from 70 to 79 years (PR:1.31; 95%CI: 0.96-1.795), 80 years or older (PR:1.64; 95%CI:1.12-2.70), history of hospitalization (PR: 1.46; 95%CI: 1.02-2.09) and low weight (PR: 5.45; 95%CI: 3.77-7.88). *Conclusions:* The prevalence of LMR in the sample is expressive, it is related to older age, hospitalization and low weight. LC monitoring is important for tracking changes related to low muscle reserve in older people and associated factors should be considered in anthropometric assessments for this population.

Keywords: Older Person. Aging. Body composition. Nutritional status.

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INTRODUCTON

One of the most prominent phenomena in this 21st century is population aging, the older population has increased considerably and according to projections, in 2060, 33.7% of the population will be older people[1,2,3]. This fact reflects achievements, but constitutes challenges for the promotion of healthy aging. The prevention and adequate control of the high prevalence of non-transmissible chronic diseases and geriatric syndromes in older people are emphasized, which have a strong relationship with the nutritional status and body composition of individuals[4,5].

During the aging process, physiological changes occur, with emphasis on changes associated with body composition, such as accumulation of abdominal fat and loss of muscle mass. In this sense, the assessment of muscle mass to estimate protein reserve based on the leg circumference measurement is a relevant alternative to assess the loss of muscle mass in this population[6].

Among the possible outcomes resulting from low muscle reserve in older people, sarcopenia stands out, a disease of multifactorial origin, which consists of the depletion of muscle mass associated with loss of strength. This condition is related to the increased prevalence of chronic non-communicable diseases, inflammation, insulin resistance, in addition to changes in functionality, which can lead to a state of dependence of the older people in daily tasks, greater risk of falls, frailty, hospitalization and death[7,8].

In view of these consequences, interest in the study of factors associated with muscle reserve deficit has been growing. In Brazil, little is known about the magnitude and determinants of this condition in the older population. Thus, the present study aimed to investigate the prevalence of low muscle reserve and identify associated factors in non-institutionalized older people in the city of Viçosa (MG) in 2009.

METHODS

Cross-sectional study, arising from the research project entitled "Health conditions, nutrition and medication use by older people in the municipality of Viçosa (MG): a population-based survey", approved by the Ethics Committee on Research with Human Beings of the Federal University of Viçosa (No 027/2008).

Sample

The study consisted of non-institutionalized older people aged 60 years or older, totaling 7980 residents in the city of Viçosa, MG. The source population was identified from a census during the National Vaccination Campaign for Older People in 2008 (80% vaccination coverage). From this census, a database was generated, which was complemented with information from the bases of occupational records and health services in the municipality.

The sample size was calculated considering a confidence level of 95%, an estimated prevalence of 50% (due to different outcomes of interest to the larger project) and a tolerated error of 3.5%[8]. By adopting these parameters, the final minimum sample consisted of 714 older people, to which 20% was added to cover possible losses, totaling 858 older people to be studied. These were selected by simple random sampling.

Data collection was carried out at the participant's home, from June to December 2009. Semi-structured questionnaires were applied and anthropometric measurements were taken, following the recommended protocols. The questionnaires were submitted to completion review by a field supervisor. After the review, data were entered twice for quality control.

Study variables

Dependent variable

The dependent variable is the low muscle reserve (LMR), obtained by measuring the leg circumference (LC). For that, a flexible and inelastic millimeter measuring tape was used, with respective capacity and precision of 1.80 m and 0.1 mm. For this measure, the most protruding part of the left leg was verified, with the older person sitting, with the left leg bent, forming a 90° angle with the knee[6]. In the present study, the classification proposed by Pagotto *et al.*

(2018)[11] who established cutoff values lower than 33 cm for women and 34 cm for men.

Independent variables

The independent variables evaluated in this study were selected based on the literature review and their availability in the project's database. They are as follows:

Sociodemographic

Information on sex (male and female), age (continuous in years and categorized into 60 to 69 years; 70 to 79; 80 years or more), education (never studied; 1 to 4 years of study; more than 4 years of study) and cohabitation (lives alone; lives with others) were evaluated.

Life habits

The variables practice of physical activity (yes; no) and diet quality assessed according to the Healthy Eating Index (HEI) were included in the study, revised and validated for the Brazilian population[11]. In order to calculate the HEI, information from the usual intake recall was used. This index considers 12 components, nine of which are from the food groups contained in the Brazilian Food Guide (2006), two nutrients (sodium and saturated fats) and SoFAAS (calories from solid fat, alcohol and added sugar)[12].

Health conditions

The variables self-perception of health (very good/good; fair; poor), history of hospitalization in the year prior to the interview (none; 1 or more), and history of the following diseases (yes; no): arterial hypertension, diabetes *mellitus*, cerebrovascular accident (CVA), heart attack, asthma or bronchitis, osteoporosis, arthritis, arthrosis or rheumatism (rheumatic disease), dyslipidemia and depression were considered.

For the assessment of functional disability, a scale with 14 types of activities was used, which include BADL (Basic Activities of Daily Life) and IADL (Instrumental Activities of Daily Life). The selection of activities to be included was based on the proposal by Katz *et al.* (1963)[13] for BADL assessment and Lawton and Brody (1969)[14] for IADL assessment. The BADLs selected in this study were: bathing; dressing up; feeding; and getting up from bed to a chair. The contemplated IADL were: preparing food or cooking; using the phone; leaving the house or taking a bus; taking medications without help; managing money; shopping; tidying up the house; performing domestic manual work; and washing and ironing clothes.

For each of the evaluated activities, the following classifications were considered regarding the difficulty in carrying it out: 1: No difficulty; 2: Has little difficulty; 3: Has great difficulty, 4: Cannot and 5: Does not do the activity. The classification of functional disability was adapted from the methodology of Fielder and Peres (2008)[15]. From the BADL and IADL set, the individual who declared some difficulty in performing six or more activities (categories 2 and 3) or when they did not feel able to perform three activities or more of the proposed total (category 4) was classified as "functional disability". The other individuals were classified as "without functional disability".

Anthropometric indicators

Nutritional status was assessed based on the calculation of the Body Mass Index (BMI) (body weight in kilograms divided by height in meters squared – kg/m^2). The cutoff points used for BMI were those proposed by the Pan-American Health Organization[16], considering underweight <23 kg/m^2, eutrophic 23 to 27.9 kg/m^2, overweight 28 to 29.9 kg/m^2, obesity ≥ 30 kg. For the purposes of the study, overweight or obesity was considered overweight.

Data analysis

A descriptive analysis of the data was carried out, through the distribution of absolute and relative frequencies for qualitative variables, and estimation of measures of central tendency and dispersion for quantitative variables. The evaluation of the normal distribution of the quantitative variables was performed using the *Shapiro-Wilk* test. The prevalence of LMR was estimated with its respective 95% confidence interval (95% CI). The prevalence of LMR was compared according to the independent variables of interest, using Pearson's chi-square and linear trend chi-square tests. Comparisons of the means of the characteristics of interest, according to the occurrence of LMR, were performed using Student's t test.

To identify the factors associated with LMR, bivariate and multiple analyzes were performed using Poisson regression with robust variance. The variables that, in the bivariate analysis, were associated with the outcome with a *p*-value ≤ 0.20 were selected for the multiple regression analysis. In the multiple regression, the backward strategy was used, keeping in the final model those variables that were associated with low muscle reserve with *p* value <0.05. The significance level adopted for all analyzes was α = 0.05.

RESULTS

After excluding losses (death, refusal, moving to an address not located) the final sample consisted of 796 older people. However, only those with leg circumference data were considered for analysis, totaling 784 individuals. The mean age was 71 years (sd=8.1 years), with more than half being female, 52.9% (95% CI: 49.0%-56.0%).

The prevalence of low muscle reserve was 21.7% (95%CI: 18.9-24.7). As shown in Table 1, there was a significant increase in the prevalence of LMR with increasing age, 24.2% (PR=1.77; 95%CI: 1.28-2.45) and 42.0% (PR= 3.07; 95%CI: 2.22-4.27) and according to the decrease in education 9.6% (PR=0.28; 95%CI: 0.16-0.49), 22.5% (PR= 0.67; 0.50-0.90) and 33.6%. Regarding life habits, the prevalence of LMR was significantly lower among older people who practiced some regular physical exercise (17.3% vs. 23.3% (PR= 0.74; 95% CI: 0.54-1.03).

Table 1. Low muscle reserve according to sociodemographic characteristics and lifestyle habits of older people. Viçosa, MG, 2009.

Variables	Total (n=784)	With LMR (n=170)		Without LMR (n=614)		p Value	PR (95% CI)
	n	n	%	n	%		
Sociodemographic							
Sex							
Male	369	75	20.3	294	79.7	0.217*	1
Female	415	95	22.9	320	77.1		1.13 (0.86-1.47)
Age group							
60 to 69 years	388	53	13.7	335	86.3		1
70 to 79 years old	277	67	24.2	210	75.8	**<0.001****	1.77 (1.28-2.45)
80 years or older	119	50	42.0	69	58.0		3.07 (2.22-4.27)
Education[1]							
Never studied	128	43	33.6	85	66.4		1
1 to 4 years of study	498	112	22.5	386	77.5	**<0.001****	0.67 (0.50-0.90)
More than 4 years of study	157	15	9.6	142	90.4		0.28 (0.16-0.49)
Cohabitation							
Lives alone	93	20	21.5	73	78.5	0.543*	1
Lives together	691	150	21.7	541	78.3		1.01 (0.67-1.53)

to be continued

Continuation of Table 1

Variables	Total (n=784)	With LMR (n=170)		Without LMR (n=614)		p Value	PR (95% CI)
	n	n	%	n	%		
Life Habits							
Practice of physical activity [1]							
No	557	130	23.3	427	76.7	0.048*	1
Yes	225	39	17.3	186	82.7		0.74 (0.54-1.03)
Diet Quality [1] mean (sd)	64.53 (10.81)	63.27 (11.19)	_	64.76 (10.65)	_	0.111***	0.99 (0.98-1.00)

LMR: Low muscle reserve; PR: prevalence ratio; 95% CI: 95% Confidence Interval

[1] The n may vary according to missing data in the respective analyzed variables. Education (n= 783), physical activity (n= 782), diet quality (n=782).

* Pearson's Chi-Square Test. **Linear Trend Chi-Square Test. ***Student's t test.

According to health conditions, the prevalence of LMR was significantly higher among older people with a history of hospitalization in the previous year 29.5% vs. 20.4%; PR= 1.45; 95%CI:1.06-1.98) and with functional disability 33.3% vs. 19.2%; (PR=1.74; 95%CI: 1.31-2.31). Conversely, a lower prevalence of LMR was observed among those with dyslipidemia 17.7% vs.82.3%; PR=0.66; 95%CI: 0.51-0.87). When considering anthropometric indicators, the prevalence of LMR among underweight older people was 4.69 times greater than the prevalence among eutrophic older people (PR = 5.69; 95% CI: 3.94 – 8.23) and the prevalence among those with excess weight was 72% lower than among eutrophic individuals (PR = 0.28; 95% CI 0.13 -0.64) (Table 2).

In the multiple regression analysis, it was observed that the factors independently and positively associated with low muscle reserve were the age range from 70 to 79 years (PR: 1.31; 95%CI: 0.96-1.79), 80 years or more (PR:1.64; 95%CI:1.12-2.70), underweight (PR: 5.45; 95%CI:3.77-7.88) and history of hospitalization (PR: 1.46; 95%CI: 1.02-2.09). Excess weight was negatively associated with the outcome (Table 3).

Table 2. Low muscle reserve according to health conditions and anthropometric indicators of the sample. Viçosa, MG, 2009.

Variables	Total (n=784)	With LMR (n=170)		Without LMR (n=614)		p Value	PR (95% CI)
	n	n	%	n	%		
Health Condition [1]							
Self-perception of health							
very good/ good	344	65	18.9	279	81.1		1
Regular	367	79	21.5	288	78.5	0.099*	1.14 (0.85-1.53)
Bad/Very bad	50	16	32.0	34	68.0		1.69 (1.07-2.68)
Hospital admission history							
None	658	134	20.4	524	79.6	**0.025***	1
1 or more	122	36	29.5	86	70.5		1.45 (1.06-1.98)
Functional Disability							
No	642	123	19.2	519	80.8	**<0.001***	1
Yes	141	47	33.3	94	66.7		1.74 (1.31-2.31)

to be continued

Continuation of Table 2

Variables	Total (n=784)	With LMR (n=170)		Without LMR (n=614)		p Value	PR (95% CI)
	n	n	%	n	%		
History arterial hypertension	596	126	21.1	470	78.9	0.489*	0.90 (0.66-1.21)
History of diabetes mellitus	172	40	23.3	132	76.7	0.323*	1.09 (0.80-1.49)
History of CVA[a]	47	14	29.8	33	70.2	0.166*	1.40 (0.88-2.23)
Heart attack history	46	5	10.9	41	89.1	0.062*	0.49 (0.21-1.12)
History of asthma or bronchitis	123	34	27.6	89	72.4	0.056*	1.34 (0.97-1.85)
History of osteoporosis	108	24	22.2	84	77.8	0.488*	1.03 (0.70-1.50)
History of rheumatic disease	180	41	22.8	139	77.2	0.700*	1.06 (0.78-1.45)
History of dyslipidemia	440	78	17.7	362	82.3	**0.003***	0.66 (0.51-0.87)
History of depression	141	30	21.3	111	78.7	0.890*	0.97 (0.68-1.38)
Anthropometric Indicators[1]							
Body Mass Index							
eutrophy	294	30	10.2	264	89.8		1
Low weight	136	79	58.1	57	41.9	**<0.001****	5.69 (3.94-8.23)
Overweight	241	7	2.9	234	97.1		0.28 (0.13-0.64)

CVA: cerebrovascular accident; LMR: low muscle reserve; PR: prevalence ratio; 95% CI: 95% confidence interval

[1] The n may vary according to missing data in the respective analyzed variables. Self-perceived health (n=761), history of hospitalization (n=780), functional disability (n=783), arterial hypertension (n=783), diabetes mellitus (n=783), CVA (n=783), heart attack (n=783), asthma or bronchitis (n=782), osteoporosis (n=783), rheumatic disease (n=782), dyslipidemia (n=781), depression (n=783) body mass index (n=671).

* Pearson's Chi-Square Test. **Linear Trend Chi-Square Test. ***Student's t test.

Table 3. Final model of the multiple regression analysis of the association between the sociodemographic variables, life habits characteristics, health conditions and anthropometric indicators with low muscle reserve among the older people. Viçosa, MG, 2009.

Variables	Low muscle reserve		
	PR	95% CI	p-value*
Age group			
60 to 69 years	1.00	-	-
70 to 79 years old	1.31	0.96-1.79	0.081
80 years or older	1.64	1.12-2.70	**0.011**
Hospital admission history			
None	1.00	-	-
1 or more	1.46	1.02-2.09	**0.037**
Body mass index			
Eutrophy	1.00	-	-
Low weight	5.45	3.77-7.88	**<0.001***
Overweight	0.28	0.12-0.63	0.002*

PR: prevalence ratio; 95% CI: 95% Confidence Interval. *Poisson regression with robust variance

DISCUSSION

The present study identified a high prevalence of low muscle reserve, as more than 1/5 of the older people had this condition. This finding corroborates the results of Martins Resende *et al.* (2017)[18] who, when observing older people in Uberaba, found a prevalence of LMR of 20.9%, measured by LC, using the cutoff point proposed by the World Health Organization (1995)9 (< 31 cm of LC for reduced muscle mass). On the other hand, it was lower than that found by Machado *et al.* (2019)[19], who observed a prevalence of 28.4% of low muscle reserve in community-dwelling older women in São Paulo, based on dual-energy X-ray absorptiometry (DXA). Higher values were also observed by Pagotto *et al.* (2018)[10], using the LC measurement, with a 25.9% prevalence of LMR in women and 30.8% in older men treated in primary care in Goiás.

Differences in the prevalence of LMR measured by the leg circumference may be related to the measurement method and the cutoff points adopted to classify low muscle reserve, as well as the source population of the older people who were part of the study samples. It is important to emphasize that there is no validated criterion for the older population and the criterion adopted by the present study is more sensitive than that proposed by the WHO (1995)[9], in order to have an impact on the increase in the prevalence of LMR.

More recent studies have focused on sarcopenia, a condition associated with low muscle reserve and decreased muscle strength[7]. In Brazil, a systematic review on the subject showed a prevalence of sarcopenia of 20% among women and 12% among men[20]. The diagnosis of sarcopenia is performed by combining different methods, including muscle mass detection methods such as DXA, bioelectrical impedance (BEI) and muscle mass prediction by LC. Associated with this quantification, it advocates the assessment of muscle strength, in which a dynamometer is used, an instrument that measures handgrip strength[6]. In this sense, recent studies highlight LC as a more accessible marker, when compared to the others, important for screening individuals affected by the disease[10,18,21] and widely used for the indirect assessment of muscle mass in population studies[21,22,23].

As for the associated factors, it was observed that the prevalence of low muscle reserve was higher in the more advanced age groups, which can be partially explained by physiological changes related to aging, such as lack of appetite, lower consumption of protein sources due to difficulties in chewing and changes in body composition[24,25]. This association is consensually reported in the literature. Gonzalez *et al.* (2021)[26] observed a strong correlation between LC and muscle mass reserve, with a decrease in values as age advances, especially in women.

In the present study, low muscle reserve was associated with a history of hospitalization. The literature points out that low muscle reserve is one of the determining factors for greater chances of hospitalization, propensity for respiratory diseases and functional disability in older people[27]. On the other hand, it also recognizes that hospitalization, for different reasons, predisposes to loss of lean body mass[7]. In the present study, the cross-sectional design limits the establishment of the direction of this relationship, so that it is not possible to establish whether the hospitalization history is a consequence of muscle loss or whether the muscle loss results from the hospitalization history.

Despite this limitation, this result highlights the importance of minimizing muscle reserve losses in order to avoid conditions that predispose to hospitalization and other consequences. Thus, it is important to ensure conducts that allow the prevention of low muscle reserve, such as regular monitoring of the LC measurement, promotion of oral health, encouragement of physical activity, in addition to nutritional conducts such as the adequate supply of protein foods in the older people's meals, and if necessary, supplementation. Such strategies are also important in the hospital environment in order to minimize muscle loss and its outcomes, considering that sarcopenia affects approximately 13% to 24% of hospitalized individuals[28].

Regarding life habits, the practice of physical activity helps in the formation and maintenance of muscle mass, however, this did not remain independently associated with low muscle reserve in our study. The absence of this association can be attributed, in part, to the inaccurate way of measuring this variable, obtained by self-report, without detailing the time spent in physical activities.

Low weight was independently associated with low muscle reserve in older people, in line with what was observed by Nunes *et al.* (2021)[29] with older people from the community, in a city in the interior of São Paulo. In older individuals, the deficit in protein consumption and muscle synthesis implies an adaptation of the organism, characterized by a physiological compensation that results in greater storage of body fat[24,25]. Thus, there is an imbalance between fat mass and muscle mass that results in an inflammatory process due to changes in anabolic and catabolic mediators. With the reduction of concentrations of anabolic hormones such as testosterone, growth hormone (GH), insulin and IGF-1, catabolism is observed, which prevents muscle synthesis[30].

It was observed that excess weight in older people had a negative association with LMR, although it is expected that in aging there will be a depletion of muscle mass and an increase in adipose tissue, located mainly in the abdominal region of older individuals. However, the association between overweight and health risk still lacks consensus. In the older population, according to the "obesity paradox", excess weight has shown a protective effect on mortality. Despite this, studies show that the redistribution of fat is capable of permeating tissues and organs. Thus, it is important to control and monitor comorbidities associated with excess weight, as these can lead to a reduction in quality of life, with an increase in the occurrence of functional disability and frailty[31]. Functional capacity, in turn, has an important relationship with muscle reserve.

As this study has a cross-sectional design, it does not allow establishing a cause and effect relationship between the observed associations. It stands out as strong points, the fact that it is a study with a representative sample of older people, carried out by properly trained interviewers to assess anthropometric measurements based on well-established protocols. We highlight the use of LC, an easy to assess and non-invasive measure that has been considered an important marker for the diagnosis of sarcopenia in older people[10,21].

CONCLUSION

More than 1/5 of the older people in the study were classified as having low muscle reserve from the leg circumference. This event was related to age, history of hospitalization and low weight. Actions that promote the healthy aging of the population should include the implementation of measures that act to improve lifestyle habits, with emphasis on the promotion of healthy eating and physical activity. Such measures can have a great impact on the maintenance of muscle mass, strength and physical performance. Subsequent studies are needed to establish the best LC cutoff point for predicting LMR, given the lack of a validated cutoff point for the Brazilian older population. Despite this limitation, monitoring LC in older people is important for tracking and following changes related to low muscle reserve.

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