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Prevalence of sarcopenia components and associated socioeconomic factors among older adults living in rural areas in the state of Ceará, Brazil

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Abstract *The aim is to determine the prevalence of sarcopenia components and associations with socioeconomic variables in older persons living in rural areas in the state of Ceará, Brazil. We conducted a cross-sectional study with 274 older adults. Muscle mass was assessed using muscle mass index (MMI), measured by bioelectrical impedance analysis and calf circumference. Muscle strength (MS) was assessed using the handgrip test. Physical performance was measured using the walk test to calculate gait speed (GS) and the timed up-and-go test. Probable sarcopenia was defined as the presence of low MS, while confirmed sarcopenia was defined as the presence of low MS and low MMI. Severe sarcopenia was defined as the presence of the latter two criteria and slow GS. We tested for associations between sociodemographic characteristics and lifestyle habits and the components of sarcopenia. The logistic regression produced the following results: i) prevalence of low MS was higher among men, individuals aged >69 years, and in those not working at the time of the study; ii) the prevalence of low MMI was higher in individuals aged >69 years, those not living with a spouse, and those with an inadequate level of physical activity; iii) the prevalence of slow GS was higher in individuals aged >69 years, those who had lived in rural areas for less than 30 years, and those not working at the time of the study.*

Key words *Sarcopenia, Older persons, Prevalence*

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Introduction

Demographic patterns are changing in Brazil due to a significant increase in the older population. According to World Health Organization forecasts, Brazil will have the sixth-largest population of older persons in the world (32 million) in 2025[1].

Sarcopenia is an age-related disease. According to the European consensus on its definition and diagnosis, sarcopenia is a muscle disease resulting from multiple changes that accrue across a lifetime characterized by decreased muscle strength associated with low muscle mass. When these two criteria are combined with poor physical performance, the condition is considered severe. Sarcopenia is associated with an increased risk of falls, fractures, physical disability, and mortality[2]. In addition, the presence of sarcopenia increases the risk of hospitalization and patients with the condition on admission are more likely to have higher hospital costs[3].

A population-based study with 1,168 older persons in São Paulo in 2010 reported that the sarcopenia prevalence rate was 4.3% among women and 5.5% in men[4]. Another study undertaken between July 2016 and April 2017 with 205 older women in the state of Rio Grande do Sul found a prevalence rate of 2.4%, with prevalence being higher in women living in urban areas (5.7%) when compared to those in rural areas (0.7%)[5].

Population-based studies investigating sarcopenia prevalence in Brazil are limited to more developed regions and have not examined the association between the presence of the disease and social and economic factors.

Research on the prevalence of sarcopenia and its components among older persons living in predominantly rural areas and disadvantaged areas is thus important, not only because of the lack of data, but also to promote public policies to minimize the adverse effects of this condition on the quality of life of the older population. This study therefore aimed to determine the prevalence of the components of the definition of sarcopenia and associated socioeconomic factors among older persons living in a rural area in the state of Ceará.

Methods

We conducted a cross-sectional study with a randomly selected sample of older persons living in Potengi, Ceará. The municipality is located 485 km from the state capital Fortaleza, has an estimated population of 10,986 inhabitants, and covers an area of 338.7 sq km[6].

Study population

The sample was made up of people aged 60 years and over living in urban and rural areas in 2019. However, both areas are characterized as having a rural way of life due to the occupation of the study sample and the municipality's rural nature[7].

A total of 542 older persons were randomly selected from the municipality's family health service registry. The following individuals were excluded: those with cognitive impairment suggestive of dementia or advanced Parkinson's disease; bedridden individuals; those with post-stroke complications such as muscle weakness or aphasia; those with visual and hearing impairments that hamper communication; amputees who were unable to walk without the aid of a prothesis or another person; and people fitted with a pacemaker, who are unable to undergo a bioelectrical impedance analysis (BIA).

A total of 371 older persons were considered eligible after applying the above exclusion criteria. There were 31 losses during the assessments and 66 refusals, resulting in a final sample of 274 individuals.

Data collection

The data were collected in the local health center to make it easier for the older persons to participate in the data collection process.

We used a sociodemographic questionnaire and the International Physical Activity Questionnaire (IPAQ) short form[8]. The questionnaires and tests were administered by four health professionals with a degree, who were trained and calibrated in standardized procedures.

Tests were also performed to diagnose sarcopenia according to the definitions proposed by the latest European consensus, published in 2019[3]. Probable diagnosis was defined as the presence of low muscle strength (MS), while confirmed diagnosis was defined as the presence of low MS and low muscle mass index (MMI). The presence of low MS and low MMI, combined with poor performance in the 4.6 meter usual gait speed test (GS) indicated severe sarcopenia[3]. MS was tested by measuring hand grip strength using a hand dynamometer, MMI was estimated

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based on the BIA, and physical performance was measured using the GS test.

Sociodemographic questionnaire

The questionnaire was devised to obtain the following information: i) demographic data and residence (sex, age, who the participant lives with, home ownership); ii) length of time living in a rural area; iii) level of education (if the participant went to school); iv) source of income (pension, other income); and v) active lifestyle (current occupation, level of physical activity).

International Physical Activity Questionnaire (IPAQ)

To measure physical activity, initially a list was drawn up of work and leisure physical activities practiced by a convenience sample consisting of 30 older persons living in urban and rural areas in Potengi. In the present study, leisure and sport activities and exercise were classified as leisure physical activity. The participants were asked whether they had practiced each of the activities from the two lists (leisure and work) during the last seven days. When the reply was yes, they were asked how many times and how long in minutes each activity had lasted on average.

To assess energy expenditure, we calculated the total weekly time (TWT) spent on each activity by multiplying the number of times the activity was performed during the last seven days by the time spent on each occasion. Each activity was then classified based on the metabolic equivalent of task (MET) as follows: i) light: between 1.5 and 2.99 METs; ii) moderate: between 3.0 and 5.99 METs; and iii) vigorous: 6.0 METs or more[9]. The TWT of the work and leisure activities in the same category (light, moderate, or vigorous) were added together to obtain the total weekly time spent on moderate intensity physical activity (TWTMPA). TWTMPA of ≥150 minutes was classified as adequate, while TWTMPA of <150 minutes was classified as inadequate[10].

Assessment of muscle strength (MS)

MS was assessed by measuring hand grip strength using a manual hand dynamometer (SAEHAN SH 5001). The test was performed with the participant seated with the elbow flexed to 90 degrees and squeezing the dynamometer for six seconds. Three measurements were taken with one-minute intervals. MS was measured in kg force using the average of the three assessments. Hand grip strength of less than 16 Kgf for women and 27 for men was classified as low MS[3,11].

Assessment of muscle mass (MM)

BIA was performed with a single 50kHz frequency system with tetrapolar electrodes (Maltron BioScan 916, Maltron, Rayleigh, United Kingdom). The measurements were taken with the participant lying down and, according to the recommendations, participants had not drunk coffee or caffeinated drinks in the last 24 hours, had not exercised, had fasted for four hours, had an empty bladder, and were not wearing metal objects[12]. MM based on BIA was divided by height^2 to obtain the muscle mass index (MMI). The cut-off for low MMI was less than 7 Kg/m^2 in men and 5.5 Kg/m^2 in women[3].

MM based on calf circumference (CC) was assessed with the participants standing upright with their feet 20 cm apart by measuring the widest part of the calf using a 1.5 m non-elastic measuring tape. The cut-off for low MM was CC<31 cm for both sexes, according to the European consensus on the definition and diagnosis of sarcopenia[2].

Assessment of physical performance

Physical performance was assessed using the 4.6 m walk test. A total distance of 8.6 m is walked, with two meters for acceleration and two meters for deceleration. The participant is timed over a distance of 4.6m to calculate gait speed (GS)[13,14]. The cut-off for slow GS was ≤0.8 m per second for both sexes.

The other test used to assess physical performance was the timed up-and-go (TUG) test, where the participant stands up from a chair, walks a short distance (3 m), turns around, and returns to sit down[15]. Performance was considered abnormal when the participant took more than 20 seconds to complete the test for both sexes[3].

Data analysis

MS, MMI, GS, and CC were converted into dichotomous variables in accordance with the 2019 European consensus on Sarcopenia[3].

The distribution of the categorical variables was described using absolute and relative fre-

quencies. The association between the independent categorical variables (sex, age, income, home ownership, length of time living in rural areas, education, living with a spouse, current occupation, and level of physical activity) and the outcomes low MS and MMI and slow GS was tested using the chi-squared test (or Fisher's exact test) and simple logistic regression equations.

The combined association of the independent variables with each outcome was tested using multiple logistic regression equations. All independent variables with p-value≤0.2 in the simple logistic regression were included in the full model. The independent variable with a p-value≥0.05 and odds ratios closest to 1 was then excluded to obtain the reduced model. The reduced model was then compared to the full model using the likelihood ratio test and when the p-value was ≥ 0.05, the reduced model was selected (principle of parsimony). These cycles of elimination were repeated until a regression equation with independent variables with p-values of <0.05 was obtained[16].

Ethical aspects

The study protocol was approved by the academic institution's research ethics committee (reference code CAAE: 66527617.6.0000.5049).

Results

The mean age of the study sample was 72 years, with 45.6% (125) of the participants being aged between 60 and 70 years and 54.4% (149) between 71 and 95 years. Over half of the sample (56% or n=154) were women.

Of the three components of the definition of sarcopenia, low MS and slow GS showed the highest prevalence (20.4% and 15%, respectively). The prevalence of low MMI was 7.3%. With regard to severity, 20.4% of the sample had probable sarcopenia, 2.6% had confirmed sarcopenia, and had 0.7% severe sarcopenia (Table 1).

The findings show a significant association between low MS and sex, age, and current occupation (p≤0.004). No significant association was found between this outcome and the other variables (p≥0.135) (Table 2).

The prevalence of low MMI was significantly higher among individuals aged over 70, those whose income came exclusively from pensions, and those who lived with their spouse than in the other category of these variables (p≤0.026). This was not the case with the other variables (p≥0.059) (Table 3).

There was a significant association between slow GS and age, living in rural areas, not going to school, and current occupation (p≤0.039). The prevalence of slow GS was significantly higher among individuals aged over 70 years and over, those who had lived in rural areas for less than 30 years, those who did not go to school, and those who were not working at the time of the study (p≤0.039). No association was found between the other variables and slow GS (p≥0.153) (Table 4).

The combined association between the independent variables and outcomes low MS, low MMI, and slow GS was assessed using multiple logistic regression equations (Table 5). After adjusting for the effects of sex and age, low MS was significantly associated with current occupation (p=0.001), with older persons who were not working at the time of the study being 3.86 more likely to show low MS than those who were working. Sex and age were significantly associated with slow GS regardless of the effect of current occupation (p≤0.014).

There was a significant association between low MMI and age, living with a spouse, and level of physical activity (p≤0.024). After adjusting for age, individuals who did not live with a spouse were 3.12 times more likely to have low MMI than those who did. The odds ratio was 3.33 times higher in participants with an inadequate level of physical activity than those who had an adequate level.

After adjusting for age, length of time living in rural areas and current occupation were significantly associated with slow GS (p≤0.022). Older persons who had lived for less than 30 years in rural areas and those who were not working at the time of the study were 2.65 and 5.09 times, respectively, more likely to have slow GS.

Discussion

The prevalence of sarcopenia, defined as low FM + low MMI, was 2.6% in the present study (95%CI: 1.0-5.2). Sarcopenia prevalence varies considerably in the literature, probably due to the heterogenous nature of study populations and different techniques used to assess MM[17]. According to Arai *et al.*[18], rates varied between 1% and 29% across the studies investigated, with the prevalence rate found by the present study being situated on the right of this spectrum.

Table 1. Prevalence of sarcopenia and its components in a sample of older persons (N=274) living in rural areas in the state of Ceará.

Components of the definition of sarcopenia	Total	Prevalence	
		N	%
Muscle strength (kgf) (FM)			
Normal	274	218	79.6
Low		56	20.4
Muscle mass index (mm/height²) (MMI)			
Normal	274	254	92.7
Low		20	7.3
Gait speed (meters/second) (GS)			
Normal	274	233	85.0
Low		41	15.0
Calf circumference (cm) (CC)			
Normal	274	232	84.7
Low		42	15.3
Timed Up and Go (3 meters) (TUG)			
Normal	274	269	98.2
Abnormal		5	1.8
Sarcopenia - MS+MMI			
Absent	274	267	97.4
Present		7	2.6
Sarcopenia - MS+MMI+CC			
Absent	274	272	99.3
Present		2	0.7

Source: Authors.

Table 2. Association between the variables and muscle strength (MS) in a sample of older persons (N=274) living in rural areas in the state of Ceará.

Variables	Total	Prevalence of Low MS		p
		N	%	
Sex				
Male	120	34	28.3	0.004
Female	154	22	14.3	
Age (year)				
60-70	125	13	10.4	<0.001
71-95	149	43	28.9	
Income				
Pension	218	46	21.1	0.591
Pension + other income	56	10	17.9	
Home owner				
No	29	9	31.0	0.135
Yes	245	47	19.2	
Length of time living in rural areas				
<30 years	49	10	20.4	0.995
≥30 years	225	46	20.4	
Went to school				
No	180	41	22.8	0.184
Yes	94	15	16.0	
Lives with spouse				
No	101	22	21.8	0.673
Yes	173	34	19.7	
Current occupation				
No	180	46	25.6	0.004
Yes	94	10	10.6	
Level of physical activity				
Inadequate	79	16	20.3	0.961
Adequate	195	40	20.5	

Source: Authors.

Other studies in Brazil have reported different rates to the present study, with the "Epi-Floripa Elderly Study"[19] reporting rates of 17% (95%CI: 12.4-22.9) in women and 28.8% (95%CI: 21.3-37.7) in men. The SABE study, which investigated the prevalence and associated factors for sarcopenia, dynapenia, and sarcodynapenia among older persons living in São Paulo[20], reported a sarcopenia prevalence rate of 4.8%, which is similar to our findings. The findings of the SABE study and present study therefore complement each other, helping to better determine the prevalence of sarcopenia in Brazil.

Differences in prevalence rates between studies may be partially explained by the use of different criteria when diagnosing sarcopenia due to changes in the definition between the 2010 and 2018 consensuses[2,14]. In addition, individual, behavioral, and social characteristics, as well as differences in lifestyle and occupation may result in differences in sarcopenia prevalence rates across population studies with older persons.

The prevalence of probable sarcopenia (low MS) was 20.4% in the present study, with the rate being higher among men. This phase of the disease is the best moment for intervention, as sarcopenia is still in the early stages, and the early detection and treatment of the disease among older persons should be a public policy priority.

Our study shows that the prevalence of low FM and MMI and slow GS increased with age,

Table 3. Association between variables and muscle mass index (MMI) in a sample of older persons (N=274) living in rural areas in the state of Ceará.

Variables	Total	Prevalence of low MMI		p
		N	%	
Sex				
Male	120	9	7.5	0.910
Female	154	11	7.1	
Age (year)				
60-70	125	4	3.2	0.017
71-95	149	16	10.7	
Income				
Pension	218	20	9.2	0.017
Pension + other income	56	0	0.0	
Home owner				
No	29	3	10.3	0.454
Yes	245	17	6.9	
Length of time living in rural areas				
<30 years	49	4	8.2	0.765
≥30 years	225	16	7.1	
Went to school				
No	180	14	7.8	0.673
Yes	94	6	6.4	
Lives with spouse				
No	101	12	11.9	0.026
Yes	173	8	4.7	
Current occupation				
No	180	17	9.4	0.059
Yes	94	3	3.2	
Level of physical activity				
Inadequate	79	9	11.4	0.097
Adequate	195	11	5.6	

Source: Authors.

Table 4. Association between variables and gait speed (GS) in a sample of older persons (N=274) living in rural areas in the state of Ceará.

Variables	Total	Prevalence of slow GS		p
		N	%	
Sex				
Male	120	15	12.5	0.313
Female	154	26	16.9	
Age (year)				
60-70	125	7	5.6	<0.001
71-95	149	34	22.8	
Income				
Pension	218	36	16.5	0.156
Pension + other income	56	5	8.9	
Home owner				
No	29	3	10.3	0.590
Yes	245	38	15.5	
Length of time living in rural areas				
<30 years	49	12	24.5	0.039
≥30 years	225	29	12.9	
Went to school				
No	180	35	19.4	0.004
Yes	94	6	6.4	
Lives with spouse				
No	101	18	17.8	0.311
Yes	173	23	13.3	
Current occupation				
No	180	37	20.6	<0.001
Yes	94	4	4.3	
Level of physical activity				
Inadequate	79	8	10.1	0.153
Adequate	195	33	16.9	

Source: Authors.

confirming the findings of other studies reporting decreasing muscle strength, loss of muscle mass, and declining muscle function with increasing age[21-23]. Adebusoye *et al.*[24] found a 9% increase in the risk of developing sarcopenia each year after the age of 60, while Barnes *et al.*[25] observed significantly lower MS in the 66-82 year age group when compared to the 45-60 year group.

Low MMI was significantly higher in older persons who did not live with a spouse and whose income came exclusively from pensions. One possible explanation for this finding is that older persons who are separated from or have lost their partner or live alone are more likely to feel lonely or live in social isolation, and thus lose motivation to perform daily activities, such as preparing meals, physical activity, and social interaction[26,27], thereby leading to a reduction in mobility, independence, and physical function, which in turn can contribute to the development of sarcopenia.

However, a study conducted in 2003 found that older people who live alone were less likely to have functional impairment than those living with other people of the same age, resulting in higher levels of independence and autonomy in the former[28]. Another study reported that older persons living with children or grandchildren

Table 5. Logistic regression including muscle strength, muscle mass index, and gait speed and the variables sex, age, current occupation, living with spouse, level of physical activity, and living in rural areas in a sample of older persons (N=274) living in rural areas in the state of Ceará.

Outcome: Independent variables - Risk categories	Odds ratio	Standard error	95%CI	p
MS: sex, age, and work				
Male	3.43	1.19	1.74-6.76	<0.001
71-95 years	2.45	0.89	1.20-5.00	0.014
Not working	3.86	1.63	1.69-8.83	0.001
MMI: age, spouse, and PA				
71-95 years	3.78	2.22	1.19-11.96	0.024
No	3.12	1.57	1.16-8.38	0.023
Inadequate	3.33	1.69	1.23-9.05	0.018
CC: age, rural, and work				
71-95 years	3.86	1.72	1.61-9.27	0.003
<30 years	2.65	1.12	1.15-6.09	0.022
Not working	5.09	2.86	1.69-15.34	0.004

Notes: Muscle strength (MS), Muscle mass index (MMI), Gait speed (GS), Current occupation (Work), Living with spouse (spouse), Level of physical activity (PA), Living in rural areas (Rural).

Source: Authors.

showed functional impairment and needed assistance, resulting in a higher prevalence of sarcopenia[29]. However, these associations observed by cross-sectional studies do not mean that it is possible to conclude that there is causal relationship between living with children or grandchildren and sarcopenia or that this type of living arrangement is due to needs related to sarcopenia or functional dependency.

The prevalence of older persons living with children (43%) and grandchildren (23%) was high in the present study; however, no association was found between this factor and low FM and MMI and slow GS. Epidemiological studies of aging in the northeast of Brazil have shown that a high percentage of older persons live in multigenerational households; however, it is probable that this phenomenon is not related to sarcopenia, but rather socioeconomic conditions[30].

The only component of sarcopenia associated with slow GS was education level, with prevalence being significantly higher among older persons who did not go to school. Given that home ownership and education are related to socioeconomic status, it is to be expected that older persons with a higher socioeconomic status have better access to information, which in turn contributes to the adoption of healthy lifestyle habits, such as a healthy and balanced diet and regular physical exercise[31], resulting in better health status and physical functioning. Low education (less than 8 years of education) has been associated with poor physical functioning and/or physical performance[32], as found in the present study.

A high percentage of our sample worked during childhood or adolescence. In addition, the most common occupation in both men and women was working the land (agriculture). The variables working the land and working with animals were not associated with sarcopenia or the components of sarcopenia.

The occupation of individuals who did not work the land or work with animals was classified as domestic work. Slow GS was associated with domestic work, with prevalence being higher among individuals with this occupation, such as maids or cleaners (38.5%). This may be explained by the fact that occupations related to the land and animals involve more strenuous tasks than domestic work.

Prevalence of low MS and low MMI and slow GS was significantly higher among individuals who were not working at the time of the study. It is known that working after the age of 60 or 65 can have positive health consequences, such as protection against cognitive decline, greater physical capacity and autonomy, and better health status among those who work than those who retire[33,34]. These findings therefore provide important inputs for prospective studies investigating the potential protective effect of work for

sarcopenia among older persons. Similar results were found by Confortin *et al.*[19], with the findings of the crude analysis showing that men who remained inactive or that stopped working were more likely to have sarcopenia (OR: 3.63; 95%CI: 1.22-10.79).

It is important to highlight some of the study limitations. First, cross-sectional studies are limited in their ability to determine a temporal cause-and-effect relationship between variables. The second, and no less important, is the small sample size and low number of individuals with sarcopenia. In addition, unlike other studies in Brazil, based on the recommendations of the European sarcopenia consensus, we used a cut-off value for CC, which may have influenced the sarcopenia prevalence rate[35]. It is very probable that some non-significant associations between the variables and sarcopenia would have been significant if the sample size and/or number of individuals with sarcopenia and its components had been larger.

However, despite these limitations, this study has several strengths. The first is the reliability of the tests and questionnaires used in the study, resulting in rigorous measurements carried out by specially trained health professionals. Second, many of the variables analyzed by the study and associated with sarcopenia are factors and/or lifestyle habits that are changeable and can be addressed by interventions, meaning that it is possible to develop or restructure health promotion strategies directed at the older population. Finally, the study sample was selected from a population different to those in large urban centers.

The sarcopenia prevalence rate found by the present study is similar to other studies in Brazil, with our findings showing an increase in prevalence with increasing age and higher prevalence in older persons whose income comes exclusively from pensions, who did not live with a partner, and were not working at the time of the study.

Studies like the present one, which focus on both the prevalence of sarcopenia and associated factors that can be addressed by health interventions, make an important contribution to the improvement of public health policies directed at this age group.

Collaborations

AAGS Rodrigues: conception, planning, analysis, interpretation and writing of the work. JWO Lima: analysis and interpretation. AA Peixoto Júnior: interpretation and writing of the work. ES Soares: interpretation, approval of the final version of the manuscript and writing of the work. CL Borges: interpretation and writing of the work.

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