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Original Article

SARCOPENIC OBESITY NEGATIVELY AFFECTS MUSCLE STRENGTH, PHYSICAL FUNCTION AND QUALITY OF LIFE IN OBESE ELDERLY WOMEN

OBESIDADE SARCOPÊNICA NEGATIVAMENTE AFETA FORÇA MUSCULAR, FUNÇÃO FÍSICA E A QUALIDADE DE VIDA EM MULHERES IDOSAS OBESAS

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RESUMO

Avaliamos o efeito negativo da obesidade sarcopênica (OS) sobre a força muscular, função física e qualidade de vida em idosas obesas usando o índice de massa magra apendicular (IMMA) ajustada para o IMC, e aLM ajustado pela estatura e massa gorda residual. Participaram cinquenta e oito mulheres idosas obesas com idade entre 60 a 70 anos de idade separadas por dois grupos: OS e não sarcopênica (NS) em duas abordagens diferentes. A prevalência de OS também foi verificada entre os métodos e seus efeitos sobre a força de preensão manual, massa magra, teste de sentar e levantar, *time-up-and-go* e caminhada de seis minutos, pico O2, recuperação de frequência cardíaca e qualidade da vida. O grupo de OS apresentou significativamente menor massa magra, menor força de preensão manual, pontuação inferior nos testes funcionais, baixa aptidão física, menor redução da frequência cardíaca durante a recuperação e aspecto inferior da qualidade de vida em comparação com o grupo NS. Além disso, nenhuma idosa foi classificada com OS pelo aLM ajustado pela estatura e massa gorda residual. O ponto de corte abordado pelo aLM/IMC representa uma ferramenta importante na prática clínica geriátrica para identificar e prevenir os efeitos deletérios da OS em mulheres idosas.

Palavras-chaves: Força muscular. Qualidade de vida. Obesidade. Sarcopenia.

ABSTRACT

We evaluated the negative effect of sarcopenic obesity (SO) on muscle strength, physical function and quality of life in obese elderly women using the appendicular lean mass (aLM) adjusted for BMI, and aLM adjusted for height and fat mass residuals approach. Participated fifty-eight obese elderly women aged 60 to 70 years separated by two groups (SO) and non-sarcopenic (NSO) in two different approaches. The prevalence of SO was also verified between methods and its effects on handgrip strength, lean body mass, chair-stand test, time-up-and-go test, six-minute-walk test, peak O_2 consumption, heart rate recovery and quality of life. The SO group presented significantly lower lean body mass, lower handgrip strength, inferior scores in the functional tests, inferior aerobic fitness, an impaired heart rate recovery, and an inferior aspect of quality of life as compared with the NSO group. Furthermore, no elderly woman was classified with SO by the aLM adjusted for height and fat mass residuals method. The cutoff-point addressed by the aLM/BMI represents a tool in clinical geriatric practice to identify and prevent this obesity/muscle syndrome in elderly women.

Key words: Muscle strength. Quality of life. Obesity. Sarcopenia.

Introduction

Sarcopenia is the process of age-related muscle loss associated with low muscle strength and physical function[1]. The establishment criteria for identifying subjects with sarcopenia remains a matter of debate and consensus on what constitutes a deficient muscle mass. Different approaches such as the ratio of appendicular skeletal muscle mass and height squared (aLM/ht²) has been widely used[2]. In addition, based on the literature review, ten studies used the aLM to define sarcopenia[3]. However, this approach requires further refinement as it was based in a small and unknown representative population of the Rosetta Study[2].

In elderly subjects, the ratio of aLM/ht² and residuals[4,5] result in different classifications. The aLM/ht² results in a higher prevalence of sarcopenia in subjects with body mass index (BMI) < 25 and 25 ≤ BMI < 30 kg/m², while residuals result in a higher prevalence of sarcopenic subjects with < 25, 25 ≤ BMI < 30 kg/m², BMI ≥ 30 kg/m², and was more strongly associated with lower extremity functional limitations in elderly women,

indicating that fat mass should be considered when estimating the prevalence of sarcopenia in obese elderly women[4]. Furthermore, residuals method of sex-specific 20th percentile was arbitrarily chosen, and more studies are needed to validate the optimal criteria for determining sarcopenia.

The Foundation for the National Institutes of Health (FNIH) sarcopenia project that incorporates an exceptionally large, diverse, and well-characterized set of populations that gives support for the generalizability of their findings recommends cutoff values for weakness and low lean mass in women, using the aLM adjusted for BMI[6]. The European Working Group on Sarcopenia in Older People (EWGSOP), developed a practical clinical definition for the diagnostic criteria for sarcopenia that constitutes of low muscle mass, low muscle strength, and low physical performance; suggesting a conceptual staging of 'presarcopenia', 'sarcopenia', and 'severe sarcopenia'. In addition, other methods of calf circumference might be applied for sarcopenia diagnosis, while it results in lower sarcopenia prevalence when compared with aLM/h²[7].

As cited by Newman et al.[4], the relationship between sarcopenia and functional limitation is not well established. We also need to consider the effects of a high fat mass on physical capacity, as older subjects tend to gain fat mass as they age. The sarcopenic obesity (SO), indicated by muscle loss with fat gain increases the risks of mobility disability, falling, low quality of life and independence, and reductions in muscle strength and aerobic fitness[8,9]. Furthermore, SO women have a significantly lower global physical capacity score when compared with sarcopenic/nonobese and nonsarcopenic/nonobese subjects[10], indicating that adiposity might be a stronger predictor of physical capacity in elderly women than muscle mass. However, for the diagnosis of SO there is no universally adopted definition as different methods and cutoff values to categorize subjects as sarcopenic and obese must be considered[10]. A cutoff proposal was introduced, for Brazilian elderly women who presented a residual equal to or below -3.4 are considered to have SO[9].

Thus, the primary objective of the present study was to evaluate the effects of SO on muscle strength, physical function, and quality of life in obese elderly women by two different approaches[4-6]. Second, we compared the prevalence of SO using two diagnostic criteria as aLM adjusted for BMI used in previous studies[6,11,12] and residuals method of sex-specific 20th percentile of -3.4[4,5,9]. Considering that SO depends on accurate body composition techniques and diagnostic criteria, our hypothesis is that SO has negative effects on muscle strength, physical function, quality of life, and prevalence differs between the different approaches employed.

Methods

Participants

A cross-sectional study was carried out evaluating elderly women from the Centro de Convivência do Idoso located at Catholic University of Brasilia; recruited for participation in the via guest lectures. To be eligible for participation in this study, women needed to be aged 60-100 years with body fat percentages ≥ 38% as assessed by dual-energy X-ray absorptiometry (DXA)[2]. Exclusion criteria included history of heart failure, valvular or congenital disease, pacemaker implantation, or osteo-articular disorders. A total of 157 older women were assessed for eligibility and completed a self-report questionnaire that accounted for cardiovascular disease, hypertension, diabetes, osteoporosis, or musculoskeletal conditions that may have precluded subjects from safely completing the physical function tests assessed in this study. Elderly women were classified as hypertensive and type 2 diabetes mellitus by the diagnostic criteria used in previous studies[13-15]. Of those, 99 were excluded (did not meet inclusion criteria), and 58 subjects met the inclusion criteria. The present study was approved

by the Institutional Research Ethic Committee of Catholic University of Brasília (UCB) (protocol 45648115.8.0000.5650/2016). The study design and employed procedures were in accordance with ethical standards and the Declaration of Helsinki. Each subject was fully informed about the risks associated with study participation and gave their written informed consent.

Sarcopenia and sarcopenic obesity

Prevalence of sarcopenia was defined by the aLM adjusted for BMI < 0.512[6]. Obesity was considered as a body fat percentage ≥ 38%[2]. The association of a low aLM adjusted for BMI[4,6] plus a high body fat percentage[2] was considered SO[8] by this first approach. The second method used to classify SO was the residuals previously reported (-3.4)[9]. The prediction equation of a previous study was used: AFFM = -14.529 + (17.989 x height in meters) + 0.1307 x total kg of fat mass[9]. Thus, elderly subjects presenting a residual value < 3.4 (measured AFFM minus the AFFM predicted by the equation) were classified as SO[9].

Body composition

Body composition procedures have been described in detail elsewhere[16] and percent body fat and appendicular skeletal muscle mass [leg + arms muscle mass (kg)/height (m²)] were determined via DXA (General Electric-GE model 8548 BX1L, year 2005, Lunar DPX type, Software Encore 2005; Rommelsdorf, Germany). The coefficient of variation for the percent body fat estimated by DXA was 12.88 and 12.84% for the SO and NSO groups, respectively classified by the first approach. All metal objects were removed from the participant before the scan. Central obesity was also evaluated by the waist-to-height ratio[17].

Assessment of physical capacity

Functional fitness was measured by time-up-and-go test (TUG), six-minute walk test, and 30-s chair-stand. Handgrip strength (HGS) was determined by the use of a handgrip hydraulic dynamometer, according to the same procedures of a previous study (Saehan Corp®, SH5001, S. Korea)[16,18-20]. Three measures on the right and left hand were obtained and the highest value for each hand was recorded. Subjects were positioned so that the forearm was in a neutral position with the elbow fully extended. While standing, standardized verbal encouragement was implemented for all participants with one-minute rest intervals between measurements. The relative handgrip strength was calculated using the participant's BMI. This approach is considered one of the most accurate relative strength index in clinical settings for elderly subjects[21].

Leisure type physical activity (LTPA)

The LTPA was evaluated based on a previous study[22]. Elderly subjects were asked to classify the type, frequency and duration of LTPA during the previous month, with several examples of exercise modalities. On the basis of Ainsworth et al.[23], compendium of physical activities, a metabolic equivalent value (MET; 1 MET = 1 kcal per h/kg of bodyweight) of 3.0 METs for conditioning exercise (Cod 02130), 3.0 METs for walking (Cod 17200), 4.0 METs for water activities (Cod 18355), 5.0 METs for dancing (Cod 03020) and 2.5 METs for stretching (Cod 02100) was used. For subjects who indicated activities in more than one intensity category, a weighted MET value was applied, considering the length of time engaged in each category. Considering LTPA volume as being the product of intensity (MET) and the duration of exercise (h), the calculated MET-h per week of each subject was obtained.

Evaluation of quality of life

Quality of life was evaluated by the Medical Outcomes Survey Short-form General Healthy Survey (SF-36) translated and validated for the Brazilian population[24]. A higher score for the SF-36 indicate a better health-related quality of life.

Treadmill stress testing

Exercise testing procedures in the laboratory have been described in detail elsewhere[25]. Subjects were encouraged to exercise until volitional-exhaustion. Achievement of 85% of age-predicted maximum heart rate (HR) and/or respiratory exchange ratio > 1.02 were used for testing termination[25]. During each exercise stage and recovery stage, symptoms (chest discomfort, rate of perceived exertion, and dizziness), blood pressure, and HR were recorded. Following peak exercise (maximum time spent in the test), participants walked for a 2-minute cool-down period at 2.0 km/h and 2.5 % grade[26]. Heart rate recovery was measured during the 2-minute cool-down period and was defined as the difference between HR at peak exercise and at 1 and 2 minutes following exercise. For safety purposes, subjects were allowed to lean on handrails during exercise. A chronotropic index less than 0.80 was considered chronotropic incompetence and was calculated by the following equation [(HRstage – HRrest)/(220 – age in years – HRrest)] x 100[27].

Data analysis

All data reported in table are presented as means and ± standard deviation. All statistical analyses were conducted using SPSS software version 18.0 (SPSS Inc., Chicago) and normality was verified by Shapiro-Wilk test. Unpaired *t*-tests were used to compare SO vs. NSO groups. For non-parametric variables (MET/h per week, quality of life, and disease), a Mann-Whitney U and Chi square for proportions were used (Fisher exact test when cells with expected values were less than five as essential hypertension and calcium channel antagonist's variables) and Cramer's V test of association was applied. An alpha level of $p \leq 0.05$ was considered significant.

Results

The prevalence of SO identified by the first method[6] was higher ($N = 14$) and no prevalence of SO was identified by the residuals method applied in Brazilian elderly women[4,5,9]. Thus, only the results from the first method were reported. There were no differences between groups for age, MET/h, and weight (see Table 1) total body fat and BMI. Waist/height ratio was significantly higher and lean body mass was significantly lower in the SO group when compared with NSO group (see Table 1).

Table 1. Participant's characteristics

	aLM adjusted for BMI (6)		
	SO	NSO	*p* value
Elderly women (*N* = 58)	14	44	
Age (years)	68.85±5.92 (65.43-72.27)	66.13±4.74 (64.69-67.57)	0.084
MET/h per week†	6.90±7.38 (2.64-11.16)	8.97±5.91 (7.17-10.77)	0.193
Height (m)	1.48±0.04 (1.45-1.50)	1.55±0.05 (1.54-1.57)	0.001
Weight (kg)	75.21±10.55 (69.11-81.30)	72.29±9.76 (69.32-75.26)	0.345
BMI (kg/m²)	34.20±3.59 (32.13-36.28)	29.71±2.94 (28.82-30.61)	0.001
Total body fat (%)	46.53±2.40 (45.14-47.92)	42.77±3.22 (41.79-43.76)	0.001
Total body fat mass (kg)	34.28±5.83 (30.91-37.65)	30.41±5.82 (28.63-31.18)	0.035
Arms lean body mass (kg)	4.19±0.54 (3.87-4.50)	4.56±0.53 (4.40-4.72)	0.027
Legs lean body mass (kg)	12.03±1.74 (11.02-13.03)	12.97±1.40 (12.54-13.39)	0.045
Total body lean mass (kg)	16.22±2.01 (15.05-17.38)	17.53±1.82 (16.97-18.09)	0.026
Waist/height ratio	0.68±0.05 (0.64-0.71)	0.58±0.05 (0.56-0.59)	0.001

Note: values are expressed as mean (standard deviation) and confidence interval (CI), BMI = body mass index, SO = sarcopenic obesity, NSO = nonsarcopenic obesity, $p < 0.05$ SO vs. NSO, aLM = appendicular lean mass, † = non-normally distributed variable.
Source: Authors

The SO group presented a lower absolute and relative handgrip strength, superior TUG test time, lower chair-stand repetitions, lower six-minute walking test, lower treadmill exercise time, lower peak O_2 consumption, and impaired 2 minutes HR recovery as compared with the NSO group (see Table 2). For the other variables no differences were identified (see Table 2).

Table 2. Physical capacity

	aLM adjusted for BMI (6)		
	SO	NSO	*p* value
Elderly women (*N* = 58)	14	44	
Right handgrip strength (kg)	22.92±4.87 (19.97-25.87)	26.04±4.57 (24.65-27.43)	0.038
Left handgrip strength (kg)	21.38±3.50 (19.26-23.50)	23.63±4.90 (22.14-25.12)	0.129
Relative handgrip strength (kg/kg)	0.89±0.11 (0.82-0.96)	.1.10±0.16 (1.05-1.5)	0.001
Tug (seconds)	7.46±1.06 (6.82-8.11)	6.71±0.75 (6.48-6.94)	0.006
Chair-stand (repetitions)	13.61±2.18 (12.29-14.93)	13.84±2.60 (13.04-14.63)	0.778
Six-minute-walking (m)	436.45±45.70 (408.83-464.07)	491.51±46.94 (477.23-505.78)	0.001
Treadmill exercise time (minute)	6.04±1.61 (4.88-7.19)	7.63±1.92 (7.00-8.26)	0.006
Peak O_2 consumption (ml/kg per min)	15.80±2.01 (14.35-17.24)	17.71±3.15 (16.67-18.74)	0.022
Basal heart rate (bpm)	74.20±6.10 (69.83-78.56)	72.97±11.27 (69.26-76.67)	0.530
Peak heart rate (bpm)	138.00±11.12 (130.04-145.95)	142.39±19.48 (135.98-148.80)	0.458
Chronotropic index	0.82±0.17 (0.70-0.94)	0.88±0.24 (0.80-0.96)	0.503
1 minute HR recovery (bpm)	16.80±6.51 (12.14-21.45)	21.55±9.80 (18.33-24.77)	0.079
2 minutes HR recovery (bpm)	24.50±6.24 (20.03-28.96)	32.13±11.24 (28.43-35.82)	0.034

Note: values are expressed as mean (standard deviation) and confidence interval (CI), BMI = body mass index, SO = sarcopenic obesity, NSO = nonsarcopenic obesity, HR = heart rate, aLM = appendicular lean mass, $p < 0.05$ SO vs. NSO
Source: Authors

There was no difference between groups for the presence of hypertension ($X^2(1) = 0.52$, $p = 0.53$, Cramer's V = 0.09) and diabetes ($X^2(1) = 0.02$, $p = 1.00$, Cramer's V = 0.01).

When compared with SO group, the NSO group demonstrated a tendency toward a statistically significant improvement on quality of life as assessed by vitality, social functioning, and mental health (see Table 3).

Table 3. Quality of life

	aLM adjusted for BMI (6)		
	SO	NSO	*p* value
Elderly women (*N* = 58)	14	44	
Physical functioning (IQR)†	70,00 (75.00)	80,00 (75.00)	0.335
Role-physical functioning (IQR)†	62.50 (100.00)	100.00 (100.00)	0.177
Bodily pain (IQR)†	56.50 (78.00)	67.00 (78.00)	0.109
General health (IQR)†	67.00 (45.00)	68.50 (60.00)	0.183
Vitality (IQR)†	60.00 (45.00)	68.50 (60.00)	0.077
Social functioning (IQR)†	75.00 (62.50)	87.50 (62.50)	0.078
Role-emotional functioning (IQR)†	49.99 (100.00)	100.00 (100.00)	0.190
Mental health (IQR)†	52.00 (32.00)	56.00 (36.00)	0.087

Note: aLM = appendicular lean mass, † = non-normally distributed variables expressed as median and interquartile range (IQR), SO = sarcopenic obesity, NSO = nonsarcopenic obesity
Source: Authors

Discussion

The aim of the present study was to evaluate the effect of SO on muscle strength, physical function, and quality of life in obese elderly women by two different approaches[4-6], and to compare the prevalence of SO using two diagnosis criteria, aLM adjusted for BMI[6] and residuals method of sex-specific 20th percentile of -3.4[4,5,9]. A higher prevalence of SO was identified using the aLM adjusted for BMI (*N* = 14), while no subjects with SO were identified using the residuals method. Moreover, SO resulted in lower absolute and relative handgrip strength, worse TUG test time, lower chair-stand repetitions, lower six-minute walking test, lower treadmill exercise time, lower peak O_2 consumption, impaired 2 minutes HR, and also a tendency to impaired quality of life as compared with the NSO condition.

A reason for this higher prevalence might be explained by the different cutoff values adopted between studies[3,8], while a higher prevalence is observed when the aLM adjusted for BMI is used when compared with aLM adjusted for height and fat mass residuals[9]. In addition, SO definitions were developed in other ethnic groups different from the Brazilian population.

Furthermore, as mentioned in the FNIH sarcopenia project, an exceptionally large, diverse, and well characterized set of populations was used, permitting generalizability and evaluation of subgroup effects using aLM adjusted for BMI[6,11,12] when compared with the aLM adjusted for height and fat mass residuals[4]. However, considering that arbitrary definitions of SO were used, more research is needed to determine whether aLM/BMI can be of clinical utility in geriatric practice to better identify SO subjects when compared with aLM adjusted for height and fat mass residuals[9].

In the present study, SO was associated with lower lean body mass, absolute handgrip strength, relative handgrip strength, inferior scores in functional tests, inferior aerobic fitness, impaired heart rate recovery, and a tendency toward a statistically significant inferior quality of life (vitality, social functioning, and mental health), thus corroborating with previous findings[8,28]. It is possible that in elderly women with SO, sympathetic withdrawal occurs in a slower fashion versus those with NSO. Parasympathetic reactivation might be prolonged in those with SO, which may contribute to impaired heart rate recovery[29], but this hypothesis must be confirmed with further studies.

It is intuitive that consequences of a low muscle strength plus obesity acts synergistically affecting muscle strength, physical function and quality of life in women as they have a higher percent body fat and a lower lean body mass compared to men, and few studies have examined the negative effect of combined low muscle mass and obesity in

elderly women. Thus, the consequences of SO in elderly subjects should be addressed in future studies, and comparisons of cut-points of other analytic approaches that combine both fat mass and aLM derived from different studies must be investigated.

The present study has a limitation on the size of the sample, composed only of obese elderly women from the Centro de Convivência do Idoso located at Catholic University of Brasilia, so the findings cannot be generalized for all populations with obesity. Therefore, additional studies should be conducted to reinforce the importance of these results.

Conclusions

Clinically, the identification of SO subjects must also account for changes of pro-inflammatory cytokines, insulin resistance, growth hormone, testosterone and malnutrion for a better diagnosis[30]. In addition, the cutoff-point addressed in this study does not imply a threshold effect for clinical manifestations of SO. However, this represents a resource in clinical geriatric practice to identify and prevent obesity/muscle syndrome in obese elderly Brazilian women.

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