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# Association between sarcopenia, sarcopenic obesity, muscle strength and quality of life variables in elderly women

## Associação entre sarcopenia, obesidade sarcopênica e força muscular com variáveis relacionadas de qualidade de vida em idosas

Luiz S. Silva Neto[1], Margô G. O. Karnikowiski[2], Adriano B. Tavares[3], Ricardo M. Lima[4]

## Abstract

**Objective:** To investigate the association between sarcopenia, sarcopenic obesity and muscle strength and variables related to quality of life in elderly women. **Method:** The sample consisted of 56 female volunteers who underwent body composition analysis (BMI and x-ray absorptiometry dual-energy DXA). Handgrip strength was measured using a Jamar dynamometer. We used the SF-36 health questionnaire to analyze quality of life. The data were analyzed with descriptive statistics and the Pearson correlation coefficient; SPSS 15.0 was used to perform the statistical analysis. **Results:** The mean age of the subjects was 64.92±5.74 years; of the 56 volunteers evaluated, 19.64% (n=11) were classified as sarcopenic obese and 45 (80.36%) were not. Thirteen volunteers (23.21%) were classified as sarcopenic while 43 (76.78%) were not. Although there were no statistically significant differences between the studied parameters and quality of life among those with sarcopenia or sarcopenic obesity, the values were lower in affected individuals. Interestingly, handgrip strength correlated positively and significantly with all of the SF-36 dimensions except VIT (P=0.08) and SM (P=0.25). **Conclusions:** Seeing that handgrip strength is a determining factor in quality of life aspects in this population, the screening and identification of small functional changes using simple clinical measures may facilitate early intervention and help prevent disability. In contrast, neither sarcopenia nor sarcopenic obesity were found to be associated with quality of life.

**Keywords:** sarcopenia; sarcopenic obesity; aging; muscle strength; rehabilitation; quality of life.

## Resumo

**Objetivo:** Verificar a associação entre sarcopenia, obesidade sarcopênica e força muscular com variáveis relacionadas à qualidade de vida em idosas. **Método:** A amostra foi composta por 56 voluntárias do sexo feminino que se submeteram à análise de composição corporal (IMC e absortometria de raios-x de dupla energia DXA). A força de preensão palmar (FPP) foi mensurada pelo dinamômetro Jamar. Para análise de qualidade de vida, usou-se o questionário SF-36; para análise estatística, os dados foram apresentados por meio da estatística descritiva e Coeficiente de Correlação de Pearson. O *software* SPSS, versão 15,0, foi utilizado para realização de todas as análises. **Resultados:** As idosas apresentaram média de idade de 64,92±5,74 anos. Das 56 voluntárias avaliadas, 19,64% (n=11) foram classificadas com obesidade sarcopênica. Treze voluntárias (23,21%) foram classificadas como sarcopênicas. Os principais achados do presente estudo demonstraram que, embora não fosse encontrada significância estatística entre os parâmetros estudados em idosas classificadas com sarcopenia e obesidade sarcopênicae as dimensões de qualidade de vida, os valores médios foram inferiores nas acometidas. De forma interessante, a variável FPP correlacionou-se positiva e significativamente com todos os domínios do SF-36, com exceção de VIT (P=0,08) e SM (P=0,25). **Conclusões:** AFPP é um fator determinante nos aspectos relacionados à qualidade de vida na população estudada. O rastreamento e a identificação de pequenas alterações funcionais por meio de medidas clínicas simples, como a FPP, podem favorecer a intervenção precoce e prevenir incapacidades. Em contraste, sarcopenia e obesidade sarcopênica não foram associadas à qualidade de vida.

**Palavras-chave:** sarcopenia; obesidade sarcopênica; força muscular; envelhecimento; reabilitação; qualidade de vida.

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[1] Maturity University Project, Universidade Federal do Tocantins (UFT), Palmas, TO, Brazil
[2] Postgraduate Programin Science and Technology in Health, Universidade de Brasília (UnB), Brasília, DF, Brazil
[3] Master in Gerontology, Universidade Católica de Brasília (UCB), Brasília, DF, Brazil
[4] Faculty of Physical Education, UnB, Brasília, DF, Brazil
**Correspondence to:** Luiz Sinésio Silva Neto, Universidade Federal do Tocantins, Coordenação Geral da UMA, Av. NS 15, ALCNO 14, 109 Norte, CEP 77.001-090, Palmas, TO, Brasil, e-mail: luizneto@mail.uft.edu.br

## Introduction

Aging is a continuous process involving changes in several physiological systems and a decrease in functional capacity, which impacts quality of life[1,2]. The musculoskeletal system is among the systems affected by aging and involves basic body functions such as muscle contraction, movement and locomotion. An important change recognized among the elderly is the loss of lean body mass, particularly muscle mass and a concomitant decrease in strength[2,3]. This phenomenon was termed sarcopenia in a pioneering study conducted by Rosenberg[4], based on the Greek root *sarx* (flesh) and the suffix *-penia* (disability, poverty). Another known alteration of body composition associated with aging is increased fat mass, which elevates the risk of developing obesity. The World Health Organization[5] defines obesity as an excess of adipose tissue in the body and considers it a chronic disease which is directly or indirectly related with other pathological situations that contribute to morbidity and mortality, such as cardiovascular diseases, osteomuscular disorders and cancer[6].

Currently, the term sarcopenia does not refer exclusively to reduction of fat-free mass (FFM) but also to a concomitant loss of strength and muscle function. This phenomenon is observed in both men and women[7] and is associated with loss of autonomy[8], increased risk of falls[9], reduced bone mineral density[10] and a decline in functional capacity[11,12]. Moreover, it is important to mention that a recent study observed that reduced appendicular FFM (AFFM) was a significant predictor of mortality in elderly[13]. Since evidence has been reported that sarcopenia affects healthcare costs[14], this phenomenon should be better understood, particularly its effects on quality of life.

The difficulty in classifying individuals as sarcopenic represents an obstacle in clinical practice and research. A pioneering study on sarcopenia[8] proposed the cutoff point of FFM two standard deviations below the mean of a population of adults between 18 and 40 years old, similar to the way osteoporosis is classified. The cutoff values presented by the authors were AFFM (i.e., upper and lower limbs divided by height squared) below 7.26 kg/m$^2$ and 5.45 kg/m$^2$ for men and women, respectively. However, this approach has been little studied in elderly Brazilians. Lima et al.[10] observed an association between muscle strength and bone mineral density, while Oliveira et al.[11] demonstrated that the elderly individuals classified as sarcopenic had significantly lower functional capacity. It is important, however, to investigate this approach in relation to the quality of life of this population.

More recently, Newman et al.[15] highlighted the importance of considering fat mass (FM) when examining sarcopenia. These authors demonstrated that when FM is not included, individuals with high body weight are not classified as sarcopenic, although their FFM is insufficient in relation to total body size. This low FFM and high FM condition has been termed sarcopenic obesity. A study reported that sarcopenic obesity was associated with worse physical function than obesity or sarcopenia alone[16], and thus it has been identified as an important cause of frailty among the elderly[17-19]. Thus, it may influence quality of life, although further study is required.

Newman et al.[15] proposed an approach for determining low FFM adjusted for height and FM in relation to functional limitations and inflammatory markers[20] in the elderly. However, they stressed the importance of determining such an association in conjunction with other health-related variables such as strength, muscle function and quality of life indexes. Moreover, they did not establish a cutoff value for classifying sarcopenic obesity. Subsequently, Oliveira et al.[21] applied Newman et al.[15]'s approach in elderly Brazilian women, and the results showed an association between muscle strength and indexes of cardiorespiratory fitness. However, such initial data call for more detailed studies, especially studies investigating the effects of these diseases on health-related quality of life of this population. Although quality of life is a broad and subjective construct, health-related quality of life focuses on functional aspects and the health-disease process, as well as the effects of various treatments[22].

Thus, the objective of the present study was to examine the association between sarcopenia, sarcopenic obesity and muscle strength and quality of life variables in elderly women.

## Method

### Sample

The sample of this cross-sectional study included 56 women with a mean age of 64.92±5.74 (range: 60 to 79) who were recruited from among participants of the Outreach Program of the University of Maturity of the Universidade Federal de Tocantins (UFT), Palmas, TO, Brazil. All participants answered a questionnaire on medical history, hormone replacement therapy, city of birth and comorbidities.

The physical activity level of the participants was measured with the IPAQ-short version, from the International Physical Activity Questionnaire validated and adapted for Brazil. The questionnaire was administered in individual interviews, as recommended for developing countries, allowing classification as very active, active, insufficiently active and sedentary[23].

Women unable to walk without assistance, or who had a metal prosthesis, a metabolic or endocrine disorder known to affect the muscular system or a cardiac conduction abnormality that prevented participation in the evaluations were excluded. All volunteers signed an informed consent form that contained information on the procedures, risks and benefits of the research. Prior to data collection, the project was evaluated and approved by the Human Research Ethics Committee of the UFT, under protocol 076/2010.

## Evaluation of body composition

A Filizolla digital scale with an accuracy of 0.1 kg was used to measure the body mass of the volunteers, who were shoeless and wearing light clothes. Height was measured to the nearest 0.1 cm with a stadiometer (CARDIOMED, Brazil) that was attached to a wall. The body mass index (BMI) was calculated by dividing the body weight by the height squared ($kg/m^2$).

Dual-energy X-ray absorptiometry (DXA) with a Lunar DPX absorptiometer and Encore 2005 software were used to measure body composition. For this procedure, the volunteers were positioned in dorsal decubitus on the DXA table and then carefully positioned so that they were completely centered on the equipment. All evaluations were carried out by the same technician. After analyzing the entire body area, DXA allowed the bone mineral density and the tissue density to be determined. The tissues were also divided into FM and FFM. The upper and lower limbs, trunk and head were initially distinguished with program-generated lines that were later adjusted more accurately by hand. Thus, FFM values were determined for both the whole body and for the upper limbs, lower limbs and trunk.

## Identification of sarcopenic obesity and sarcopenia

Using the body composition values obtained with DXA, sarcopenic obesity was determined according to the cutoff point established by Oliveira et al.[21], which was a residual value less than or equal to two standard deviations from the mean of a reference group of young women (18 to 40 years of age). The prediction equation for AFFM in the above-mentioned study was: AFFM = -14.529 + (17.989 x height in meters) + 0.1307 x total kg of FM. The cutoff point corresponded to a residual value ≤-3.4 (i.e., the measured AFFM minus the AFFM predicted by the equation). Thus, the volunteers who showed a residual value ≤-3.4 were classified as having inadequate FFM for their body area, which indicates sarcopenic obesity. To determine sarcopenia, the cutoff point for women proposed by Baumgartner et al.[8] was adopted, i.e., <5.45 $kg/m^2$ (AFFM divided by height squared).

## Evaluation of handgrip strength

Handgrip strength was measured with a Jamar dynamometer in the following manner: the volunteers were seated in a standardized position used by the American Society of Hand Therapists in which the hips and knees are flexed at 90º, the shoulder adducted in neutral position, the elbow flexed at 90º and the forearm in semi-pronation without radial or ulnar deviation. The grip dynamometer was adjusted individually according to each volunteer's hand size, so that the bar closest to the body of the dynamometer was positioned on the second phalanges of the index, middle and ring fingers[24]. The tests were performed three times, with the dominant hand first and then the non-dominant hand, with an interval of 1 minute between each attempt in order to avoid fatigue during the test. Force was applied for 5 seconds in each attempt, and the highest value was considered[25]. The results were recorded in kg/f.

## Evaluation of quality of life

Quality of life level was measured using the Medical Outcomes Survey Short-form General Health Survey (SF-36) translated and validated for Brazil by Ciconelli et al.[26]. The scale consists of 36 items about limitations in daily life due to health problems and provides a subjective estimate of the individual's functional state. The SF-36 results in a classification of eight dimensions: physical functioning, social functioning, role limitations (physical problems), role limitation (emotional problems), mental health, vitality, pain, and general health. The answers for each dimension are coded, summed and transformed into scores from 0 to 100, where zero corresponds to "worst health" and 100 to "best health".

## Data analysis

The Kolmogorov-Smirnov test was used to verify the normality of data distribution. The data were analyzed using descriptive statistics, including mean and standard deviation. A *t* test for independent samples was used to compare the dependent variables (quality of life and handgrip strength) between volunteers with and without sarcopenic obesity. The same procedure was followed to compare those with and without sarcopenia. The chi-square test was used to verify whether there were differences between groups with respect to hormone replacement. The Pearson correlation coefficient was used to verify the relationship between AFFM variables and dependent variables. The significance level adopted was $p \leq 0.05$. SPSS 15.0 was used to perform all analyses.

# Results

The results for all variables are presented as means and standard deviations. Table 1 shows the volunteers' characteristics, including age, handgrip strength and body composition according to DXA. Table 2 presents the quality of life variables from the SF-36 questionnaire.

Table 3 shows the quality of life and muscle strength variables according to the proposed classification for sarcopenic obesity[21]. Again we point out that the model cutoff point, adapted from Oliveira et al.[21], was based on that of Newman et al.[15], which was derived from the residues of a regression that predicts AFFM from FM and height. Of the 56 evaluated volunteers, 19.64% (n=11) were classified as sarcopenic obese and 80.36% (n=45) were not. Comparing the results of sarcopenic obese women with those were not, significant differences were observed in the variables AFFM and body fat percentage. The chi-square test revealed that the number of participants who underwent hormone replacement did not differ significantly between groups. Interestingly, FFM and variables related to quality of life showed, in general, lower (although not significantly so) mean values in the volunteers classified as having sarcopenic obesity.

Table 4 shows the quality of life and the strength variables according to Baumgartner et al.[8] approach. Of the 56 participants of this study, 13 (23.21%) were classified as sarcopenic, while 43 (76.78%) were not. Significant differences were observed for the variables body weight, BMI, AFFM, body fat percentage and handgrip strength.

**Table 1.** Descriptive statistics (mean±standard deviation) of the studied variables.

| Variables | |
|---|---|
| n | 56 |
| Age (years) | 64.92±5.74 |
| Body weight (kg) | 60.55±13.15 |
| Height (m) | 1.52±0.59 |
| BMI (kg/m$^2$) | 26.14±5.12 |
| AFFM (kg/m$^2$) | 13.87±2.15 |
| Total fat mass (kg) | 25.06±8.37 |
| Grip strength (kg/F) | 25.44±5.51 |
| Body fat percentage (%) | 42.31±5.85 |

BMI=Body Mass index; AFFM=Appendicular Fat-free Mass.

**Table 2.** Descriptive statistics (mean±standard deviation) of the SF-36 quality of life dimensions.

| Variables | |
|---|---|
| n | 56 |
| Physical functioning | 78.48±19.39 |
| Role-physical | 78.44±33.76 |
| Bodily pain | 68.45±22.97 |
| General health | 77.81±14.99 |
| Vitality | 76.39±15.88 |
| Social functioning | 85.29±18.78 |
| Role-emotional | 75.58±35.67 |
| Mental health | 78.25±15.91 |

**Table 3.** Quality of life variables according to the classification of sarcopenic obesity proposed by Oliveira et al.[21].

| Variables | Sarcopenic Obesity | Non-Sarcopenic Obesity | p-value |
|---|---|---|---|
| n (%) | 11 (19.64%) | 45 (80.36%) | |
| Age (years) | 66.18±7.7 | 64.62±5.2 | 0.424 |
| Body weight (kg) | 57.60±10.26 | 61.27±13.77 | 0.413 |
| Height (m) | 1.52±0.08 | 1.51±0.05 | 0.780 |
| BMI (kg/m$^2$) | 24.83±4.4 | 26.46±5.27 | 0.351 |
| Body fat percentage (%) | 46.02±4.90 | 41.40±5.74 | 0.015 |
| AFFM (kg) | 12.27±1.69 | 14.26±2.07 | 0.005 |
| Grip strength (kg/f) | 23.09±6.74 | 26.02±5.08 | 0.115 |
| Physical functioning | 71.81±20.52 | 80.11±18.99 | 0.207 |
| Role-physical | 84.09±32.15 | 77.06±34.35 | 0.541 |
| Bodily pain | 66.90±25.29 | 68.80±22.72 | 0.816 |
| General health | 73.00±16.46 | 78.98±14.57 | 0.239 |
| Vitality | 74.54±17.09 | 76.85±15.74 | 0.670 |
| Social functioning | 78.40±29.09 | 86.97±15.30 | 0.177 |
| Role-emotional | 66.66±42.16 | 77.77±34.08 | 0.359 |
| Mental health | 76.90±22.15 | 78.57±14.29 | 0.758 |

BMI=Body Mass Index; AFFM=Appendicular Fat-free Mass.

As was observed for sarcopenic obesity, the SF-36's quality of life variables generally showed lower mean values in the elderly classified as sarcopenic. Additionally, the test chi-square test revealed that the number of participants who underwent hormone replacement did not differ significantly between groups.

Table 5 shows the correlations of residual values, AFFM and handgrip strength with the SF-36 quality of life dimensions. There were positive and significant correlations between residual values (Newman et al.[15]) and AFFM, as well as between AFFM and handgrip strength. Additionally, both the AFFM and the residual values tended toward a significant correlation with the SF-36's pain dimension (p=0.06 and 0.08), respectively. Interestingly, the variable handgrip strength was positively and significantly correlated with all SF-36 dimensions except VIT (p=0.08) and MH (p=0.25). Finally, it was observed that age was negatively and significantly correlated with handgrip strength (r=-0.30; p=0.02).

**Table 4.** Quality of life variables according to the classification of sarcopenia proposed by Baumgartner et al.[8].

| Variables | Sarcopenic | Non-sarcopenic | p-value |
|---|---|---|---|
| n (%) | 13 (23.21) | 43 (76.78) | |
| Age (years) | 65.23±7.37 | 64.83±5.25 | 0.831 |
| Body weight (kg) | 49.42±6.15 | 63.91±12.88 | <0.001 |
| Height (m) | 1.51±0.06 | 1.52±0.05 | 0.495 |
| BMI (kg/m$^2$) | 21.63±2.26 | 27.50±4.98 | <0.001 |
| Body fat percentage (%) | 39.31±6.17 | 43.21±5.50 | 0.003 |
| AFFM (kg) | 11.49±1.03 | 14.59±1.84 | <0.001 |
| Grip strength (kg/f) | 22.15±5.59 | 26.44±5.14 | 0.013 |
| Physical functioning | 80.76±15.65 | 77.79±20.50 | 0.632 |
| Role-physical | 74.23±37.74 | 79.72±32.84 | 0.612 |
| Bodily pain | 62.15±20.63 | 70.40±23.54 | 0.262 |
| General health | 74.61±13.73 | 78.77±15.38 | 0.385 |
| Vitality | 74.23±14.69 | 77.05±16.33 | 0.579 |
| Social functioning | 80.76±25.31 | 86.66±16.45 | 0.326 |
| Role-emotional | 74.34±33.76 | 75.96±36.60 | 0.888 |
| Mental health | 74.00±15.87 | 79.53±15.88 | 0.276 |

BMI=Body Mass Index; AFFM=Appendicular Fat-free Mass.

# Discussion

Although statistically significant differences were not observed between the studied variables and quality of life parameters in elderly women with sarcopenia or sarcopenic obesity, the mean values were lower in the affected women. Such results deserve attention, since sarcopenia and sarcopenic obesity have been identified as harmful to geriatric health[27] in that they entail increased risk of disease and mortality[13] and reduced functional capacity and quality of life[28-33]. Additionally, the reduced AFFM values observed in both sarcopenia and sarcopenic obesity were associated with lower values of handgrip strength. Importantly, this variable was positively and significantly correlated with the quality of life dimensions, which therefore suggests a relevant phenotype of the studied population. Jointly, the observed results suggest that handgrip strength, a relatively low cost and easy measurement, is a predictor of quality of life in the elderly. In fact, the importance of handgrip strength for individuals with advanced age is consistent with the literature[34-38].

Sarcopenic obesity, reduced FFM and increased body fat percentage[19], although only a recently identified condition, has been identified as an important cause of frailty among the elderly[19,28,39]. Thus, new insight into sarcopenic obesity becomes even more important, since the elderly population is increasing worldwide[16]. In the present study, using the classification proposed by Oliveira et al.[21] to compare the mean quality of life values between the sarcopenic obese and non-sarcopenic individuals, it was observed that the affected individuals had lower, though not statistically significant, values. Such findings may be related to the subjective nature of the questionnaire[40]. Thus, it is important to mention that a recent study[21] has demonstrated that sarcopenic obesity is related to decreased muscle strength and functional capacity in the elderly. Moreover, Bouchard and Janssen[41], in a cross-sectional study involving 2,039 men and women over 55 years of age, observed that sarcopenic obesity was associated with poorer functioning when compared separately to either obesity or sarcopenia.

**Table 5.** Correlations between residuals, Appendicular fat-free mass and grip strength with SF-36 quality of life dimensions.

| Variables | Residuals | AFFM (kg) | Grip strength (kg/F) | PF | RP | Pain | GH | Vitality | SF | RE | MH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Residuals | - | 0.58* | 0.20 | 0.07 | 0.01 | 0.23 | 0.08 | 0.14 | 0.16 | 0.08 | 0.01 |
| AFFM (kg) | 0.58 * | - | 0.41* | 0.12 | 0.08 | 0.25 | 0.15 | 0.09 | 0.19 | 0.04 | 0.03 |
| Grip strength (kg/F) | 0.21 | 0.41* | - | 0.35* | 0.37* | 0.40* | 0.29* | 0.23 | 0.38* | 0.26* | 0.16 |

AFFM=Appendicular Fat-free Mass; PF=Physical Functioning; RP=Role-Physical; GH=General Health; SF=Social Functioning; RE=Role-Emotional; MH=Mental Health.

Using Baumgartner et al.[8] approach for sarcopenia classification (i.e., AFFM divided by the height squared less than 5.45 kg/m$^2$), a prevalence of 23.21% was observed, which is similar to other studies involving elderly Brazilian women[8,9]. Similar to what was observed for sarcopenic obesity, the SF-36 quality of life dimensions did not differ significantly in the affected women, although the mean values were lower. However, it was observed that handgrip strength was lower in the sarcopenic seniors, and this variable was significantly associated with quality of life[42,43]. It is worth repeating that the general concept of quality of life is broad and subjective, involving the individual's perception of life as well as his expectations and concerns[44]. Nevertheless, in the 1990s, the term "health-related quality of life" emerged, which is focused on the health-disease process, functional aspects and their impact on an individual's daily life. This outcome, specifically, was the object of the present study, although "quality of life" was used generically throughout.

Consistent with previous findings[38,42,43,45,46], the observed results highlight the importance of handgrip strength as a predictor in the elderly. Its usefulness is enhanced by its broad applicability, low cost, quick implementation and non-invasiveness. In particular, our results suggest an association between handgrip strength and health-related quality of life in the studied population, since there was a correlation with most of the dimensions, specifically physical functioning, social functioning, role limitations (physical problems), role limitation (emotional problems), as well as reference to pain and general health. Dixon et al.[47], in a study involving men and women over 50 years of age, demonstrated that handgrip strength in women was associated with low bone mineral density of the spine and hip as well as an increased risk of fractures, regardless of lifestyle or differences in body size. Importantly, handgrip strength has even been associated with mortality in individuals with advanced age. In a 25-year longitudinal study conducted by Metter et al.[48], it was demonstrated that handgrip strength has an impact on mortality from all causes and that although low lean body mass is important, it did not totally explain the effects of strength. Moreover, Galley et al.[49], in a 24-year longitudinal study, observed that handgrip strength is a long-term predictor of mortality from all causes, including cardiovascular diseases, as well as from cancer in men. Finally, the negative correlation observed between age and handgrip strength in the present study indicates that after 60 years of age this variable declines.

The results of this study have important clinical implications. Regarding the functional evaluation of the elderly, muscle strength, especially handgrip strength, stands out as a non-invasive and low cost measurement that is easy to implement. Additionally, regarding the adoption of preventive or therapeutic measures for the elderly, interventions that minimize sarcopenia-related phenotypes, especially muscle strength, warrant attention. Thus, the adoption of a physically active lifestyle has been consistently associated with the preservation of body mass and muscle strength, with resistance training and appropriate nutrition being of particular relevance[2,50].

The present study has some limitations. Since the volunteers were Brazilian women, the results cannot be extrapolated to other populations or to men. Moreover, the cross-sectional design does not allow the establishment of a cause-effect relationship, although it provides evidence that the dependent variables are associated with handgrip strength. Finally, cutoff points for classifying sarcopenia and sarcopenic obesity should be better defined in the literature. Nevertheless, the selected cutoff points had been previously used with elderly Brazilian women and were significantly associated with muscle strength, bone mineral density and functional capacity[10,11,21].

## Conclusions

Based on the observed results, although there were no significant associations between sarcopenia and sarcopenic obesity with the quality of life dimensions, they were associated with reduced handgrip strength values. On the other hand, handgrip strength was positively and significantly correlated with various dimensions from the SF-36 test, suggesting its importance as a predictor of quality of life in elderly women. Consistent with previous findings, this study demonstrates that handgrip strength is a low cost, easy to implement measurement that can be incorporated into the clinical routine of health professionals, aiding in prevention and intervention procedures.

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