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Physical performance and its association with anthropometric and body composition variables in the elderly

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Abstract *The aging process leads to biological changes that affect the physical performance and nutritional status of older adults. The objective this study is to determine the association between physical performance and anthropometric and body composition variables in the elderly. This is a cross-sectional study. Were assessed: sex, age, handgrip strength (HGS), flexibility/mobility, balance, body mass index, waist and calf circumference, triceps skinfold thickness, arm fat area and arm muscle circumference. Multiple logistic regression was used (p<0.05). Overall, 420 elderly were evaluated. Malnourished individuals were more likely to show poor HGS. Elderly aged 70-79 years, 80 years or older and those malnourished were more likely to show poor balance. Older women were less likely to show poor flexibility/mobility. We conclude that lowercalf circumferencewas associatedwithworse performance inHGSand balance.The ageincreased the chanceof the elderlypresentinstability.The flexibility/mobilitydoesn't seem tobe influenced bychanges in body composition. Therefore, these resultsmay beimportantguidingspecific actionsto ensurehealthy aging.*

Key words *Elderly, Physical performance, Anthropometry, Body composition*

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Introduction

The aging process causes a reduction of physiological reserve on different systems, contributing to progressive loss of functional capacity, and a change on the elderly nutritional status and body composition, exposing them to a state of greater vulnerability[1,2].

An important aspect of the elderly evaluation is related to functional performance, considering that the decline of physical function can be an important indicator of frailty, dependence and increased risk of institutionalization of this population[3]. Muscle strength, balance and flexibility are physical qualities directly related to the elderly health, involved in the ability to perform daily tasks[4,5].

With aging, there is a reduction in the ability of the nervous system, involved in sensory processing and adaptive reflexes, generating situations of postural instability, changes in coordination, imbalance and increased susceptibility to falls[6]. In addition, changes occur in the nervous coordination and musculoskeletal system, leading to muscle atrophy and bone demineralization, reducing the efficiency of the locomotor system, influencing the decrease in muscle strength and flexibility[7,8].

Besides functional status, nutritional status is an important indicator of health in the elderly. Changes in nutritional status with aging are related to important physical changes, such as lean mass reduction, mainly muscle mass and bone density, and increase in the redistribution of body fat, with accumulation in the trunk and viscera, and reduction in the limbs[7]. Studies with the elderly have been using anthropometry as a way to measure and monitor body changes through markers of the accumulation of fat and muscle mass, due to its low cost and ease of obtainment[1,9-11].

Functional and body composition changes, which the elderly undergo, led to studies that have sought to determine the influence of anthropometric and body composition variables in functional performance of the elderly[1,12-16]. However, some of these studies have checked the nutritional status only through an indicative variable, usually BMI, excluding, as in this study, other indicators, such as body fat distribution (waist circumference and waist-hip ratio) and percentage (arm fat area), and muscle indicators of malnutrition (calf circumference) as potential influencers of the physical performance of the elderly.

Therefore, this study sought to determine the association of functional performance with anthropometric and body composition variables in the elderly. Thus, it is expected that the study of different anthropometric variables may contribute to the identification of the most influential indicators of physical performance in this population.

Methods

This is a cross-sectional, household-based study, with primary data collection, and is part of a broader study that aimed to perform a multidimensional evaluation of health of the elderly enrolled in the Family Health Strategy in the city of Campina Grande, in the state of Paraíba (PB), Brazil.

Individuals aged 60 and over, of both sexes, were included in the sample. The elderly who presented severe clinical weakness, with no resolute therapeutic possibility, and the elderly who were away from the city of Campina Grande/PB for a period greater than that of field research in their Family Health Basic Unit (FHBU) were excluded. In addition, specific exclusion criteria were set for each functional test: the elderly undergoing a surgery in the arm or hand within the three months prior to collection were excluded from the handgrip strength test. Elderly undergoing cataract or retinal surgery, within the six weeks prior to the interview, bedridden elderly, wheelchair users, or those who, for some reason, could not stand up were excluded from flexibility/mobility and balance tests.

The largest research in which this study participated was evaluated and approved by the Research Ethics Committee (REC) of Universidade Estadual da Paraíba (UEPB) (CAAE: 0228.0.133.000-08). The elderly signed an Informed Consent when they accepted to participate in the research, according to Resolution 196/96.

Sample

According to the information by the Health Department, in 2008 there were 23,416 elderly in the city of Campina Grande who were registered in the 63 Family Health Basic Units (FHBU), distributed in the six city Health Districts. For sample selection, a prevalence of outcomes of at least 25% was estimated. The calculation of the sample size was performed using the following

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equation: $\{[E^2 \times p\ (1-p)] \times c\}/ A^2$, where *E* is confidence bound (1.96), *c* is the sample correlation coefficient (2.1), and *A* is the precision accepted for the estimated prevalence (A = 6%). From each district, one UBSF was randomly drawn, with the sample being proportionate to each Health District, with 420 elderly.

Fieldwork was performed, with three doubles of interviewers, duly trained, from August 2009 to May 2010. Information about gender, age group, physical performance, anthropometry and body composition was evaluated.

Physical Performance

The tests used to evaluate physical performance were: handgrip strength (HGS), flexibility/mobility, and balance tests. Prior to each test the elderly received explanations and practical demonstrations, to ensure the correct implementation of the task with no risk for the elderly.

Handgrip strength was measured with the use a hydraulic hand dynamometer (Takei Kiki Kogyo® TK 1201 Dynamometer, Japan), adjusted for each individual according to their hands size. Testing was performed in the limb referred by the elderly as the one of greater strength (dominant limb). During the test, the elderly stayed sat with the elbow supported on a table, forearm extended forward, palm up, and then they were asked to perform the greatest possible grip.

The procedure for measuring HGS was performed twice, with an interval of one minute between them[17] with the average being considered as final value. To assess performance in this test we used the classification used by Barbosa et al.[18], who consider the values (kg) distributed in percentiles, according to gender: poor (≤ P25), regular (> P25 and ≤ P75) and good (> P75).

The flexibility/mobility test used in this study was the "pick up a pen" test proposed by Reuben & Siu[19]. The elderly were told to stay upright, feet together, and when informed about the start of the test, should stoop down to pick up a pen, placed on the floor, 30 cm ahead of the toes. A stopwatch was used to check the time spent between stooping down and returning to starting position, with the pen in hand. The test was considered completed when the elderly could finish the exercise without support, in time ≤ 30 seconds.

For data analysis, we used the classification indicated by Barbosa et al.[18], which ranks flexibility according to the test runtime: poor (> 6 and ≤ 30 seconds), regular (> 2 and ≤ 6 seconds) and good (≤ 2 seconds).

The test to check balance consists of four measures of static balance, proposed by Guralnick et al.[20]. Each measurement was performed only once. In a first measuring, the elderly should remain upright, keeping the feet together and the eyes open. In the second, the elderly should remain upright, placing the heel of one foot in front of the other, keeping the eyes open. In the third, the elderly should remain standing, with one leg raised, leaning on the other leg, without using any other type of support. In the fourth, the later exercise was performed, but changing the position of the legs. Each measure was considered successfully completed when the elderly could stay 10 seconds in that position. If the elderly could not make the first measure, he/she should not perform the second and so on.

Performance was evaluated with the use of the classification used by Barbosa et al.[18] that evaluates the elderly based on the amount of measurements performed in the test: poor (one measure), regular (two measures) and good (three or four measures).

Anthropometry and body composition

Anthropometric and body composition variables were: body mass index (BMI), waist circumference (WC), waist-hip ratio (WHR), triceps skinfold (TSF), arm circumference (AC), arm fat area (AFA), arm muscle circumference (AMC) and calf circumference (CC).

To calculate the BMI (kg/m^2), weight and height were measured according to the techniques described in Lohman et al.[21]. Weight (kg) was measured in a portable digital scale (TANITA UM080) for 150 kg and sensitivity of 100g. Height (m) was measured in portable stadiometer (Accurate Height). The WC (cm), hip circumference (HC) (cm), AC (cm) and CC (cm) variables were measured using an inelastic tape measure with a precision of 1 mm, according to the techniques described in Lohman et al.[21]. The waist-hip ratio (WHR) was obtained by dividing WC by HC.

To calculate the AMC (cm) and AFA (cm^2), triceps skinfold (TSF) and arm circumference (AC) were measured. TSF was obtained using Lange compass, which has constant pressure of $10g/mm^2$, and measured according to the techniques described in Lohman et al.[21]. AMC was calculated with the Gurney & Jelliffe's equation[22]:

$$AMC\ (cm) = [AC\ (cm) - (\pi \times TSF\ (cm))]$$

To calculate AFA the equation proposed by Frisancho[23] was considered:

$$AFA\ (cm^2) = \frac{[AC\ (cm)^2]}{4\pi} - \frac{[AC\ (cm) - (\pi \times TSF\ (cm))]^2}{4\pi}$$

For BMI categorization, the classification proposed by the Pan-American Health Organization (PAHO)[24] was used, which defined specific cutoffs for the elderly population: low weight (< 23 kg/m^2), eutrophy (≥ 23 and < 28 kg/m2), overweight (≥ 28 and < 30 kg/m^2) and obesity (≥ 30 kg/m^2). WC and WHR were classified according to the cutoffs proposed by WHO[25], with the following being considered improper: WC > 102 cm for men and > 88 cm for women; WHR > 0.99 for men and > 0.97 for women.

The classification of WHR, AFA and AMC was made based on values described by Menezes & Marucci[11], which are presented according to the gender and distributed in percentiles (P). Based on these values, the variables were classified as follows: AMC (malnutrition (≤ P25) and eutrophy (> P25)), TSF and AFA (insufficient (≤ P25), eutrophy (> P25 and < P75) and excessive (≥ P75)). For CC, the classification proposed by the WHO was considered[25], which considers CC < 31cm malnutrition, and CP ≥ 31cm, eutrophy.

Statistic procedures

For statistical purposes, the functional performance variables were dichotomized and classified into good and bad. For good HGS, the elderly who presented regular performance (> P25 and ≤ P75) and good performance (> P75) were considered. Similarly, for the classification of good flexibility/mobility, the elderly with regular (> 2 and ≤ 6 seconds) and good (≤ 2 seconds) performance were considered. For good balance, the elderly who performed well (performed three or four measures) were considered. The others were classified as poor performance, considering that the elderly with regular balance also show some degree of instability, which may contribute to imbalance.

The data are presented in the form of frequencies. To check the association of functional performance variables with gender, age group (60 to 69 years, 70-79 years and 80 and over) and anthropometric and body composition variables, Pearson's chi-square test was used (X^2). Initially, simple logistic regression models were estimated to calculate gross odds ratio (OR). For the multivariable model the variables with $p < 0.20$ (Wald test) obtained in simple analysis were considered. The stepwise forward input method for calculating the adjusted OR was considered with 95% confidence interval (95%CI). In the final model, the variables that remained in the model with $p<0.05$ were considered significant. The evaluation of the logistic model adjustment was performed using the Hosmer-Lemeshow test. Data were analyzed using SPSS 17.0 (IBM Corp., Armonk, United States) statistical packet.

Results

The study included 420 elderly (68.1% women) with a mean age of 71.57 years (± 9.19), whose ages ranged between 60 and 104 years. Elderly people who for some reason could not perform the functional performance tests were not included in the results. Thus, the total of elderly respondents: 417 performed the HGS test; 368 the flexibility/mobility test, and 393 the balancing test.

After the associations of all anthropometric variables were associated with HGS, the following was selected in the simple logistic regression test: CC ($p < 0.0001$), AMC ($p = 0.006$), BMI ($p = 0.04$), AFA ($p = 0.009$), WHR ($p = 0.06$) and WC ($p = 0.19$), adjusted by gender ($p = 0.71$) and age ($p = 0.67$). Table 1 presents the final model of multivariable regression for HGS. Malnourished elderly were more likely to have poor HGS (OR 2.21, 95%CI: 1.15 – 4.25) compared to the eutrophic elderly. The model was adjusted by AMC, WC, gender and age group.

In simple regression test, only gender was associated with flexibility/mobility ($p = 0.02$), with age group and AFA being selected as adjustment variables for the multiple test. In the final model, adjusted for age group, the female was a protective factor for good flexibility (OR 0.35, 95% CI: 0.14 – 0.86) (Table 2). There was no significant association between the anthropometric and body composition variables and flexibility/mobility of the elderly in this study.

For association with balance, the following was selected in the simple regression test: age group ($p < 0.0001$), CC ($p = 0.001$) and AMC ($p = 0.007$). Gender was considered an adjustment variable. The final model for balance is shown in Table 3. The elderly aged 70 to 79 years (OR 3.69, 95% CI: 2.17 – 6.27) and 80 years or more (OR 12.1, 95% CI 4.59 – 32.18); and malnourished (OR 3.00, 95% CI 1.20 – 7.51) were more likely to have poor balance. The best adjustment consid-

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ered gender and also TSF, which was therefore included in the model (Hosmer-Lemeshow = 0.84).

WHR variable was not significantly associated with any of the functional performance variables, therefore not being considered in the logistic models. The corrected arm muscle area (CAMA) was not considered in this study because of its strong association with AMC ($p < 0.0001$). Therefore, as both variables are indicative of muscle mass reserve, we opted for AMC, considering that it presented the strongest association with physical performance variables.

Table 1. Final multivariable logistic regression model for HGS. Campina Grande, Paraiba, Brazil. 2010.

Model[(a)]	HGS Good %	HGS Bad %	p*	Crude OR	p**	Adj. OR	CI 95%
CC (cm)			< 0.0001		< 0.0001		
Malnutrition	53.7	46.3		2.64		2.21	1.15 – 4.26
Eutrophic	75.4	24.6		1.00		1.00	Reference

HGS: Handgrip strength; CC: calf circumference; p: significance level; 95% CI: 95% confidence interval; [(a)] Model adjusted for AMC (arm muscle circumference), WC (waist circumference), gender and age group; * Chi-square test; ** Wald Chi-square test (Simple Logistics Regression)

Table 2. Final logistic regression model for flexibility/mobility. Campina Grande, Paraiba, Brazil. 2010.

Model[(a)]	Flexibility Good %	Flexibility Bad %	p*	Crude OR	p**	Adj. OR	CI 95%
Gender			0.016		0.021		
Male	90.2	9.8		1.00		1.00	Referência
Female	96.3	3.7		0.35		0.35	0.14 – 0.86

p: significance level; CI 95%: 95% confidence interval; [(a)] model adjusted by age group; * Pearson Chi-square test; ** Wald Chi-square (Simple Logistics Regression)

Table 3. Final logistic regression model for balance. Campina Grande, Paraiba, Brazil. 2010.

Model[(a)]	Balance Good %	Balance Bad %	p*	Crude OR	p**	Adj. OR	CI 95%
Age group (years)			< 0.0001		<0.0001		
60 to 69 years	49.0	51.0		1.00		1.00	Reference
70 to 79 years	21.0	79.0		3.62		3.69	2.17 – 6.27
80 years or older	7.2	92.8		12.3		12.1	4.59 – 32.18
CC (cm)			0.001		0.001		
Malnutrition	13.8	86.2		3.55		3.00	1.20 – 7.51
Eutrophic	36.3	63.7		1.00		1.00	Reference

CC: calf circumference; p: significance level; CI 95%: 95% confidence interval; [(a)] Model adjusted for TSF (triceps skinfold) and gender; * Pearson Chi-square test; ** Wald Chi-square (Simple Logistics Regression)

Discussion

Functional capacity is an indicator of health and quality of life for the elderly, since it considers aspects such as independence and performance in their activities[4]. The elderly, even without clinical diagnosis of chronic disease, present some degree of functional loss related to the reduction of the functions of organs and body systems, inherent to aging[26]. The physical decline, in particular, is related to greater predisposition to loss of autonomy, and fragility, greater frequency and duration of hospitalizations, and increased risk of mortality[3].

This study aimed to evaluate the joint association of different anthropometric and body composition variables in functional performance of the elderly, measured by physical tests of muscle strength, flexibility/mobility and balance. Studies aiming to investigate the association between physical performance and anthropometric variables and body composition have commonly used BMI, since it is a variable that is simple to be obtained and easy to be accessed[1,12,13,16]. Other studies have considered the anthropometric evaluation through variables such as calf circumference[1,14], arm muscle circumference[12] and arm muscle area[12,16] to assess body composition.

The evaluation of muscle function has been used as a functional capacity indicator in elderly people[27]. In this regard, handgrip strength has been the most commonly measured in muscle evaluation, since it reflects the maximum strength derived from the contraction of the hand muscles, and it has a good relationship with other muscle groups. Moreover, it is a readily available measure that makes its use feasible in research and in clinical practice with the elderly[28].

In this study we observed an independent association of BMI, indicative variables of fat (AFA) and muscle reserves (AMC and CC) with the HGS, but the CC was the variable with the best association, remaining in the final model. Malnourished elderly were more likely to show poor HGS, regardless of the adjustment for other anthropometric variables (AMC and WC), gender and age group, indicating that the reduction in muscle mass is associated with decreased muscle strength.

The calf circumference is considered a sensitive measure of muscle mass in the elderly because it reflects changes in fat-free mass; thus, it is recommended for malnutrition assessment in that population[25]. Data from Invecchiamento e Longevità nel Sirente Study, an Italian population study, observed a significant relation of calf circumference and HGS ($p < 0.001$), adjusted by gender and age. Malnourished elderly have a worse average of HGS (24.4 ± 1.4 kg) compared to normal weight (35.2 ± 1.1 kg). This difference remained even with adjustment for sex and age (26.5 ± 1.2 kg and 33.7 ± 1.0 kg)[14].

In Brazil, a study of elderly in the city of Campina Grande/PB, evaluated the relationship of anthropometric variables that are indicative of muscle mass to HGS. There was a positive and significant correlation between AMC ($r = 0.30$; $p <0.01$) and CAMA ($r = 0.29$; $p <0.01$) with HGS[12]. Another study, conducted in the city of Lafaiete Coutinho, in the state of Bahia (BA), Brazil, observed similar results for the correlation of AMA with HGS, in both genders[16].

With changes in nutritional status that occur with the aging process, there is a reduction of muscle fibers and remodeling of the motor units and consequently, decreased limb muscle strength[8,10,13], which may explain the association found in studies[12,14,16], including this one, between malnutrition and muscle strength.

In addition to the amount of lean body mass, other factors seem to be associated with reduced muscle strength. A study comparing a group of old and young men observed 25% less muscle strength in the elderly compared to younger people, but there was no significant difference in the amount of muscle mass[29]. The authors also observed a reduction in the number of motor units and muscle protein in the elderly compared to the young. These results indicate that not only the reduction of the amount of mass, but also muscle quality, may be related to decreased strength[2].

Aspects that occur with aging, such as the reduction of the number of muscle fibers, changes in their structure and reduction of the neurological system efficiency to recruit motor units, lead to impairment of neuromuscular performance. Thus, there is increased muscle weakness, movement slowness and early fatigue, contributing to limitations to walk, get up, keep balance, among other daily activities, increasing the risk of falls and functional dependency[1,30].

For flexibility/mobility, the test used to assess the elderly of this study was the "pick up a pen" test, with which it is possible to evaluate the mobility of the spine and hip muscles, which commonly undergo function reduction with advancing age, causing losses in flexibility[31]. Women performed better in the test of flexibility/mobility, being less likely to have poor flexibility/mobil-

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ity compared to men. This association remained significant even after adjustment for age group.

Studies have observed a better performance of females in flexibility tests[31-33]. A cohort in Brazil, with individuals from five to 92 years of age followed, for 18 years, the changes in flexibility in seven body segments, totaling 20 joint movements. Women performed better than men in all age groups ($p < 0.0001$), with smaller reduction in annual percentage (0.6% / year) compared to men (0.8% / year) ($p < 0.0001$). The authors also found that with aging, there was decreased flexibility in both sexes; however, but this did not occur in equal proportions in all segments. It was observed, for example, a greater impact on joints of the shoulder and torso, whereas in the elbow and knee flexibility remained preserved[34]. A multicenter population-based study conducted in Spain, with older people, noted a better performance of females in the flexibility tests, both at the top and bottom of the body, bilaterally[33].

Greater flexibility/mobility among women is observed in various stages of development. Women have less dense tissue than men do. It is believed that this occurs due to the concentration of estrogen, a female hormone, which induces a higher water retention and greater accumulation of adipose tissue, favoring better performance of women in the flexibility test. Furthermore, in general, women's lumbar spine is proportionately longer and has better muscle stretchability, which leads to increased mobility of this region[32].

In general, with aging, articular capsules and ligaments become stiffer due to the loss of elastic fibers and increased collagen. Thus, this may interfere on movements and on performance of the joint receptors, making movements slower or uncoordinated, affecting the range of motion of the elderly[30]. In this study, a significant association of anthropometric and body composition variables was not observed in tests of flexibility/mobility, suggesting that there is no influence of these variables on the motor performance of the elderly population studied.

For this study, in the balance test, static balance was considered. The elderly from older age groups (70 to 79 years, 80 years or more) and those malnourished were more likely to have poor balance, when gender differences and fat accumulation are taken into account. The percentage of subjects with poor balance was three to six times higher in these groups as compared to the reference.

Studies have observed a higher prevalence of balance disorders in older age groups[33,35,36]. A study conducted in Sydney assessed the static and dynamic balance of the elderly and young people, through seven physical tests of mobility. The elderly showed worse performance compared to young people, in all tests ($p <0.001$). Moreover, elderly people of more advanced age groups showed lower values in all the tests in both sexes[37]. A cohort study of the elderly in Sweden found, in 10 years, a decline of balance from -0.95% to -2.41%/year among men and -1.61% -2.11%/year among women. The dynamic balance, observed through gait, showed more pronounced decline from 70 years of age on, in both sexes[35].

For balance control to occur, it is necessary to keep the center of gravity, on a supporting base, either in static or dynamic situations. The visual, vestibular and somatosensory systems work together to keep balance by managing the center of gravity variations. With the aging process, there is a reduction of these systems yield, decreasing the ability to compensate for variations of the center of gravity, leading to postural instabilities[38].

Malnutrition has also been associated with worse performance in balance tests[1,13,36], indicating that the reduction in the amount of muscle mass influences the occurrence of body instability and, consequently, of balance. Musculoskeletal changes that occur with aging cause muscle atrophy that, associated with bone deformities, changes the support base, which may lead to changes in postural balance[39].

Data that are similar to this study were observed in a research of elderly people in the city of Vitória de Santo Antão, in the state of Pernambuco, Brazil, in which a significant ratio of the calf circumference and static and dynamic balance tests was observed[1]. A study in Japan found a significant relation of reduction in quadriceps muscle mass and visceral fat accumulation with static and dynamic balance in the elderly[36]. In this study, the association between CC and age group was adjusted by TSF, because the presence of fat in the muscle may interfere in the muscle evaluation with the use of circumferences[1]. Thus, it is necessary to evaluate muscle function in the elderly in general, considering not only the amount and quality of muscle mass, but also the accumulation of fat.

Therefore, it is observed that differences in gender, age, and changes in nutritional status and body composition may have implications on the physical performance of the elderly, leading to an impairment of their functional capacity. Malnutrition proved to be a major factor associated with elderly poor results in strength and balance tests.

Based on this, and on the recommendations of the Policy of Active and Healthy Aging proposed by WHO[40], the following is recommended: the adoption of actions that encourage feeding in adequate quantities and quality in this population; monitoring of factors that may influence malnutrition, such as monitoring of oral health, treatment of cognitive and physical changes; encouragement for physical activity, as well as the implementation of physical activity programs in health facilities, with training plans to maintain or restore muscle strength, flexibility and balance. In the elderly who are already fragile and more functionally impaired, individual actions for specific treatment and rehabilitation are advisable.

The monitoring of the health status of a given population, as well as of factors associated with these conditions, is a key instrument for guiding strategies that lead to qualified approaches to ensure a healthy aging[5]. Once a limitation is detected, it is possible to choose the most appropriate measure to eliminate the risk factor or reduce its progression[26]. The promotion and prevention in the three health care levels mobilize the global policies discussions for a healthy aging in order to seek possible solutions to the factors involved in functional performance, and contribute to the reduction of public spending on early retirement and health care and social assistance[5,26].

This study has limitations inherent to cross-sectional studies, because although the association, and also a chance of occurrence of outcomes (HGS, flexibility/mobility and balance) have been observed, it does not establish the direction of cause and effect between anthropometry and functional performance. Another possible limitation is that the level of physical activity among older people was not evaluated, given that this may be a possible confounding factor in the behavior of associations, when active and not active elderly are considered.

These limitations, however, do not compromise the results regarding the association of body composition and anthropometry in the functional performance of the elderly. In addition, the tests used cover different physical domains, which contributes to a more comprehensive evaluation of the physical conditions, and of which anthropometric indicators have the greatest influence on them.

Conclusions

The results above show that malnourished elderly (lower CC) were more likely to have a poor HGS. There was no significant association of anthropometric and body composition variables with performance in tests of flexibility/mobility. The results also showed that women had higher levels in this test. The elderly of older age groups, and who are malnourished (lower CC), were more likely to have poor balance.

This study used a wider variety of anthropometric variables and functional tests, covering different areas to better understand aspects of nutritional status associated with reduced physical function in the elderly. It is believed that this may encourage the implementation of public health programs aimed at health maintenance, or even the recovery from morbidities such as malnutrition and other nutritional problems, and also to help health workers in the development of behaviors that allow delaying the occurrence of dependency, promoting a healthy aging with good quality of life.

Collaborations

NA Silva participated in data collection, typing, statistical analysis, discussion of data and writing of the article. DF Pedraza helped in the interpretation, discussion of data and reviewing of the article. TN Menezes participated in the study design, coordination and guidance of the study, analysis and discussion of data and final review of the article.

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