ORIGINAL ARTICLE

Higher body mass index and lower waist circumference are associated to higher physical performance (SPPB) solely in dynapenic elderly women

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ABSTRACT

Physical performance limitation is defined as difficulties in performing physical tasks. It is critical for the functional independence of the elderly. Limited physical performance is strongly associated with increased falls, hospitalizations, cardio and cerebrovascular diseases, and mortality in the elderly. The impact of body mass status and low muscle strength (dynapenia) on elderly physical performance is well documented. However, the interaction of these factors (muscle strength and body mass status) on the physical performance of the elderly is not yet clear. **Objective:** To assess the predictive power of body mass index (BMI) associated with waist circumference (WC) in determining the physical performance of older women classified as dynapenic (low muscle strength) or non-dynapenic. **Method:** One hundred forty-two older women were evaluated according to: anthropometry (BMI and WC), handgrip (HG) and physical performance (SPPB). The elderly were classified in dynapenic (HG < 20 kg) or non-dynapenic (HG ≥ 20 kg). **Results:** In both groups, multiple linear regression analysis indicated that BMI and WC were not associated with SPPB when they were analyzed separately. However, when BMI and WC were analyzed concomitantly, both were significantly associated with SPPB only for the dynapenic group. **Conclusion:** The main findings of this study suggest that WC and BMI applied together, but not separate, are predictors of physical performance in older women with dynapenia. These results are important for clinical practice because of easy application and low cost of measures.

Keywords: Sarcopenia, Women, Activities of Daily Living, Hand Strength

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INTRODUCTION

Physical capacity, defined as moving without assistance, is critical to maintaining the functional independence of the elderly.[1,2] Limitation in physical capacity, defined by the Centers for Disease Control and Prevention as difficulties in performing physical tasks (such as walking some distances, climbing stairs, lifting a chair or carrying an object with mass determines), is strongly associated with increased falls, hospitalizations, heart and cerebrovascular diseases and mortality in the elderly.[3-6] Physical capacity is measured by tests such as the Short Physical Performance Battery (SPPB).

The impact of body mass status and low muscle strength (dynapenia) on the physical capacity of the elderly is well documented.[2,8-11] The interaction of these factors (muscle strength and body mass status) on the physical capacity of older adults Is not clear. However, studies suggest that this relationship is attributed, at least in part, to the fact that the ability of the muscle (muscle strength) to transfer load (body mass) is affected by excess fat body mass.[2,10,12-14]

Elderly women with BMI above 30 kg/m^2 (obesity) are 60% more likely to suffer physical capacity decline compared to their eutrophic peers.[9,10] Interestingly, the effect of elevated BMI on impaired physical ability is exacerbated in elderly women compared to older men.[10,14] Studies suggest that this sexual difference in the physical capacity of the elderly is given by the relationship between body composition and muscle strength, since women have greater body adiposity and lower muscular strength (dynapenia) and mass (sarcopenia) Than men.[8,11,12,14] However, there is little empirical evidence to support this assumption.

Although used to determine obesity, BMI does not distinguish between fat mass (body fat) and lean body mass (muscle and bone).[15] In this sense, people with the same BMI may have different body composition. As the BMI assesses the amount of body mass (all components of body composition) per square meter, not only the greater fat mass, but also the greater muscle mass reflect in higher BMI, suggesting the need for the BMI to be corrected .[15]

An anthropometric measure of easy applicability and low cost is the measurement of waist circumference (WC). WC is used to assess the amount of core (abdominal) adiposity and its values are positively associated with impaired functional capacity in the elderly.[10,16] In women, the advent of menopause (interruption of the menstrual cycle at approximately 50 years of age) is accompanied by a change in body composition, characterized by increased adiposity, especially in the abdominal region.[17] Thus WC can provide accurate information on fat accumulation in postmenopausal women. In fact, WC has a very strong correlation (r=0.92) with the trunk fat obtained by DXA in elderly women.[16] Therefore, it seems reasonable to accept that WC is a corrective measure for BMI by providing more accurate information on body composition in postmenopausal women.

OBJECTIVE

To confirm the assumption that the relationship of muscle strength to body mass status affects physical ability in elderly women, we have determined the predictive power of BMI adjusted for WC on physical ability in elderly women with and without dynapenia. This paper discusses how the use of anthropometric measures (BMI and WC) associated with dynapenia can predict physical capacity in elderly women.

METHODS

This study, with an observational cross-sectional approach, evaluated 142 elderly women attending Geriatrics and Gerontology at the outpatient clinic of the local university hospital in the 12-month period. Exclusion criteria included psychological and physical conditions that could prevent people from completing physical tests. The morbidities were raised by means of a self-reported questionnaire and included cardiovascular disease, lung disease, arthritis, diabetes, osteoporosis, hypertension, peripheral vascular disease, and other conditions (sleep apnea, cancer and epilepsy). The selected women reported at least one comorbidity, but were able to perform the tests. This study was approved by the Ethics and Local Research Committee with protocol number 1685.0020

The evaluations were performed in the morning period by a trained and experienced evaluator in the following order: anthropometry, palmar grip strength (PGS) and physical performance by SPPB. The companions of the elderly were invited to accompany the evaluations but were told not to help. When the companions interfered, the evaluations were discarded for this study.

Anthropometric Assessment

BMI was determined by the ratio of body mass to height squared (kg/m^2). The body mass was measured on a platform-type scale (BALMAK®) with a precision of 100g and a maximum capacity of 150kg. The height was measured with a stadiometer coupled to the balance with an accuracy of 0.05cm. The WC was measured with inextensible and inelastic millimeter tape, with an accuracy of 0.5cm. The measurement was performed at the midpoint between the last intercostal arch and the iliac crest at the end of a normal expiration. The individual remained erect in the anatomical position with the feet together and the arms relaxed at the body side.[18] Values classified as overweight (high BMI) and elevated WC were older than ≥27 kg/m^2 and> 88 cm, respectively.[16,19]

Evaluation of the Palmar Holding Force

The palmar dynamometer (JAMAR®) was used to evaluate the PPF of the elderly. Three palm grips were performed in the right hand and the mean was calculated to evaluate the strength of the elderly women in the sitting position with the elbow flexed at 90 degrees.[20] The values classified as dynapenia in elderly women were <20 kg.[11]

Brazilian version of the Short Physical Performance Battery (SPPB)

The physical capacity was determined by the SPPB test. The SPPB is a test battery composed of three tests, applied in the following order: balance evaluation, walking speed of four meters and sit and stand up from the chair. The balance test was evaluated with the individual standing in three different positions with progressive decrease of the support base. In each position the time of the evaluated individual was measured, and the maximum time in each position was 10 seconds. The gait speed of four meters was determined by the time it took the individual to walk that distance at the usual self-selected speed. The lower limbs muscular strength was evaluated through five repetitions of raising and sitting on the chair in maximum speed, without the help of the upper limbs (arms flexed in front of the chest). The total SPPB score was assessed by adding the individual score of each test. The sum of the scores can vary between zero and 12 points (four points for each step of the test). The women who presented scores equal to or less than six points were determined as with low physical capacity.[11,21]

Statistical analysis

Sample characteristics values are presented as mean and standard deviation. Multiple linear regression analysis (standard method) was conducted to investigate the impact of prediction variables (BMI and WC) on SPPB. Two models were evaluated. In model 1, only age and one of the predictor variables were included in the model. In model 2, all variables (age, BMI and WC) were included in the model. The level of significance was set at $P < 0.05$.

RESULTS

The physical-functional, anthropometric and age characteristics are presented in Table 1. Women were classified, on average, as being overweight according to their BMI and with elevated WC. In addition, they had normal functional capacity (strength and SPPB), but had limited physical capacity (SPPB).

The multiple linear regression analysis (Table 2), performed to examine the importance of BMI and WC for SPPB in all women, showed that BMI and WC do not predict physical capacity (SPPB), regardless of the model used (Model 1 and 2). Interestingly, when multiple linear regression analysis was performed separately for dynapenic and non-dynapenic groups (Table 3), the predictive power of these variables differed between strength classifications. The BMI and WC variables, adjusted for age and analyzed separately, were again not associated with SPPB, regardless of muscle strength classification (Model 1). However, when analyzed concomitantly, BMI and WC were significantly associated with SPPB only in the dynapenic group (Model 2). The WC was responsible for 49% (P = 0.003) of the standardized (beta) variation of SPPB, when adjusted for BMI. The BMI was responsible for 55% (P = 0.005), when adjusted for WC. WC was a negative predictor, while BMI was a positive predictor of SPPB. For the non-dynapenic group, no interaction was observed between BMI, WC and SPPB.

Table 1. Descriptive characteristics of participants (n=142)

	Average	SD
Age (years)	67.3	12.0
BMI (Kg/m^2)	28.4	5.8
WC (cm)	92.9	15.2
SPPB, score	6.9	4.1
MGF (kg)	21.3	5.7

BMI: body mass index; SPPB: Short Physical Performance Battery; WC: waist circumference; MGF: manual grip force; SD: standard deviation

Table 2. Multiple regression analysis between Age, BMI and WC with SPPB

	All (n=142)				All (n=142)			
	Model 1				Model 2			
	Beta	EP	RP2	P	Beta	EP	RP2	P
Age	-0.70	0.05		<0.001	-0.71	0.06	-0.69	<0.001
BMI	-0.04	0.06	-0.05	0.502	-0.01	0.07	-0.01	0.904
WC	-0.05	0.05	-0.07	0.351	-0.05	0.07	-0.05	0.512

Table 3. Specific multiple regression analysis for muscle strength level between age, BMI and WC with SPPB

	Dynapenic (MGF < 20)						Non-dynapenic (FPP ≥ 20)					
	Model 1			Model 2			Model 1			Model 2		
	n=60						n=82					
	Beta	SE	P	Beta	SE	P	Beta	SE	P	Beta	SE	P
Age	-0.7	0.09	<0.001	-0.6	0.09	<0.001	-0.61	0.08	<0.001	-0.64	0.08	<0.001
BMI	0.11	0.09	0.249	0.55	0.17	0.003	-0.16	0.08	0.055	-0.18	0.1	0.067
WC	-0.03	0.09	0.703	-0.49	0.17	0.005	-0.05	0.08	0.52	0.03	0.1	0.702

WC: waist circumference; BMI: body mass index; SPPB: Short Physical Performance Battery; MGF: manual grip force; SE: standard error; Beta: coefficient of determination standardized by standard deviation. Model 1: BMI and WC were adjusted for age and individually tested. Age was tested without adjustment; Model 2; BMI, WC and age tested concomitantly.

DISCUSSION

The results of this cross-sectional observational study suggest that CC and BMI applied jointly, but not separately, are predictors of physical ability in elderly women with low (dynapenic) muscle strength.

To confirm the assumption that the relationship of muscle strength to body mass status affects physical ability in elderly women, we have determined the predictive power of BMI adjusted for WC on physical ability in elderly women with and without dynapenia. This article discusses how the use of anthropometric measures (BMI and CC) associated with dynapenia can predict physical capacity in elderly women.

According to our literature review (national and international databases), we did not find studies that examined the predictive power of BMI and WC in the physical capacity of elderly women with dynapenia. The relationship between body mass and muscle strength represents an important research area because of the implications of this relationship on physical ability. This is of particular importance for older women, as these women are more likely to have functional disability than older men.[14]

Although no studies were found that examined the predictive power of BMI and WC in physical capacity in older women, some studies have been conducted in elderly men and women together. [9,10] Schaap et al.[12] conducted a recent meta-analysis to determine the relationship between different measures of body composition (BMI, WC, hip waist ratio and body fat) and physical capacity in the elderly.

Although the meta-analysis revealed that BMI above 30 kg/m^2 was negatively associated with declining physical ability, this study did not stratify comparisons for gender or muscle strength, nor did it correct BMI for WC, which may interfere in the Interpretation of the results.[12,15] In this study, we observed that BMI, when corrected only for age, was not a predictor of physical capacity in elderly women. However, BMI became a strong predictor of physical capacity in the dynapenic group when it was adjusted for WC. However, in the non--dynapenic group BMI was a weak negative predictor of physical capacity (beta = -0.16, P = 0.055). Thus, data from this study contribute to the literature, identifying the importance of correcting BMI by WC to predict physical capacity in elderly women with dynapenia.

In this paper, BMI, when corrected by means of age and WC, was a positive predictor of physical capacity, while WC, when corrected for the BMI, was a negative predictor of physical capacity in elderly women with dynapenia (Table 2). The association between BMI and impaired physical ability is attributed, at least in part, to the ability of the body musculature to transfer load (body weight). Thus, it is accepted that this relationship between muscle strength, body mass and mobility is mainly affected by excess fat body mass. [10,12-14] However, although used to determine obesity, BMI does not distinguish between fat mass (body fat) from lean mass (muscles and bones).[15]

Thus, BMI does not appear to be an accurate prognostic measure for low functional capacity in the elderly, requiring a correction of BMI for a more precise indicator of fat. [15,22,23] WC is an excellent indicator of abdominal fat, which has a high correlation (r=0.92) with abdominal fat by the dual X-ray densitometry (DEXA) in elderly women. [16] In addition, Fortaleza et al. showed that only abdominal fat, but not total body fat or percentage of body fat, is associated with impairment of physical capacity in elderly women. [24]

During aging there are changes in body composition, such as increased body fat and decreased muscle mass and strength.[23] The association between low muscle mass and strength and excess fat is termed sarcopenic obesity.[22] Sarcopenic obesity is indicated as a strong mediator of low functional capacity and a predictor of mortality in the elderly. [23,25,26] Thus, low BMI and high WC in dynapenic women may be an indicator of sarcopenic obesity. This is of particular importance, since the diagnosis of sarcopenic obesity is performed by imaging method, such as DXA. However, due to the high cost implications, it is not performed in the outpatient setting. As an alternative, BMI, WC and dynamometry are simple and demand low-cost techniques and can be widely used in the outpatient setting.

This study has limitations that must be recognized. It was restricted to cross-sectional strategies and a small sample of women; therefore, the discriminative capacity of the BMI associated with WC cannot be generalized to different configurations (eg, elderly men). In this context, future studies should consider these associations in larger and different samples. However, our study was the first to examine the importance of BMI associated with WC for physical ability in older women, presenting new findings on practical measures for outpatient settings.

CONCLUSION

The main findings of this study suggest that WC and BMI applied jointly, but not separately, are predictors of physical ability in elderly women with dynapenia. These results are important for outpatient care because of the easy applicability and low cost of the described measures.

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