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A study on the relationship between muscle function, functional mobility and level of physical activity in community-dwelling elderly

Estudo da relação entre função muscular, mobilidade funcional e nível de atividade física em idosos comunitários

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Abstract

Objectives: to evaluate the relationship between lower extremity muscle function, calf circumference (CC), handgrip strength (HG), functional mobility and level of physical activity among age groups (65-69, 70-79, 80+) of older adults (men and women) and to identify the best parameter for screening muscle function loss in the elderly. **Methods:** 81 community-dwelling elderly (42 women and 39 men) participated. Walking speed (Multisprint Kit), HG (Jamar dynamometer), hip, knee and ankle muscle function (Biodex isokinetic dynamometer), level of physical activity (Human Activity Profile) and CC (tape measure) were evaluated. ANOVA, Pearson correlation and ROC curves were used for statistical analysis. **Results:** Dominant CC (34.9±3 vs 37.7±3.6), habitual (1.1±0.2 vs 1.2±0.2) and fast (1.4±0.3 vs 1.7±0.3) walking speed, HG (23.8±7.5 vs 31.8±10.3), average peak torque and average hip, knee and ankle power ($p<0.05$) were lower for the 80+ group than for the 65-69 year-olds. There were no differences in physical activity level among age groups. Moderate significant correlations were found between muscle function parameters, walking speed and HG; a fair degree of relationship was found between muscle function parameters, CC and level of physical activity ($p<0.05$). The ROC curve analysis suggested a cutoff point of 14.51 Kgf for screening muscle function loss in elderly women ($p=0.03$). **Conclusions:** This study demonstrated an association between muscle function, HG and fast walking speed, a decrease in these parameters with age and the possibility of using HG to screen for muscle function of the lower extremities.

Key words: aged; muscle strength; mobility limitation; gait; hand strength.

Resumo

Objetivos: Avaliar a relação da função muscular de membros inferiores (MMII), circunferência de panturrilha (CP), força de preensão palmar (FPP), mobilidade funcional e nível de atividade física (NAF) em idosos comunitários ativos com idades entre 65-69, 70-79 e 80 ou mais anos e identificar a melhor medida clínica para rastreamento de redução de função muscular de MMII em idosos. **Métodos:** Oitenta e um idosos (42 mulheres e 39 homens) submeteram-se à avaliação da velocidade de marcha (Kit *Multisprint*), FPP (dinamômetro Jamar), força e potência muscular de MMII (dinamômetro isocinético *Biodex*), NAF (Perfil de Atividade Humana) e CP (fita métrica). Procedeu-se à análise estatística com ANOVA, correlação de *Pearson* e curva *ROC*. **Resultados:** Os idosos de 80 ou mais anos apresentaram valores menores que os de 65-69 para CP dominante (34,9±3 vs 37,7±3,6), velocidade de marcha habitual (VMH) (1,1±0,2 vs 1,2±0,2) e velocidade de marcha máxima (VMM) (1,4±0,3 vs 1,7±0,3), FPP (23,8±7,5 vs 31,8±10,3), média de pico de torque (MPT) e potência média (PM) de quadril, joelho e tornozelo ($p<0,05$). O NAF não apresentou diferença significativa entre os grupos. A força e potência muscular apresentaram correlações moderadas com VMH, VMM e FPP e correlações baixas com a CP e com o NAF ($p<0,05$). A curva *ROC* sugeriu o ponto de corte de FPP de 14,51 Kgf para rastreamento de redução de função muscular nas mulheres idosas ($p=0,03$). **Conclusões:** Existe associação entre a função muscular de MMII, FPP e VMM: esses parâmetros diminuem com o envelhecimento, e a FPP pode prever redução de função muscular de MMII em idosas.

Palavras-chave: idoso; força muscular; limitação da mobilidade; marcha; força da mão.

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Introduction

Sarcopenia, defined as the slow, progressive and apparently inevitable loss of muscle mass and strength, is one of the most important physiological changes that occur with advancing age[1]. The reduction of muscle mass associated with aging seems to be the primary factor responsible for reduction in muscle strength and power and the consequent loss of functional mobility in elderly people[2-4]. It is estimated that aging is associated with 20% to 40% of the decrease in muscle strength and power at 70-80 years of age and with still greater reductions (50%) at 90 years of age in both sexes[2-4].

Associations between measures of muscle mass and function, level of physical activity (LPA) and functional mobility have been established in older adults, demonstrating that slow walking speed and reduced handgrip strength (HG) can identify those with reduced lower-limb muscle strength and power, limitations and functional decline[5-13]. Although it has been well-established in the literature that there are reductions in muscle function and LPA concomitant with aging, the best clinical parameter for screening reduced lower-limb muscle strength and power in the elderly has not yet been determined. Therefore, the aim of this study was to evaluate the relationship between hip, knee and ankle muscle strength and power and clinical measures of calf circumference (CC), HG, functional mobility and LPA among different age groups of physically active older adults and to identify the best clinical parameter for screening reduced lower-limb muscle strength and power in this population.

Methods

Type of study and ethical aspects

This was a cross-sectional observational study approved by the Committee of Ethics in Research of the Federal University of Minas Gerais, Belo Horizonte, MG, Brazil (ETIC 492/07) and carried out at the Laboratory of Motor and Functional Human Performance of the Institution. The participants signed an informed consent form.

Sample

The study sample consisted of 81 community-dwelling elderly (42 women and 39 men), stratified into three comparable age groups (65-69, 70-79 and 80+). The sample size calculation was based on a pilot study with ten senior adults (three between 65 and 69, five between 70 and 79 and two at least 80 years old) for a statistical power of 80% (β=0.20) and a non-directional test at a 0.05 (α=0.05) significance level.

Subjects were selected by convenience from the metropolitan region of a large city and had to be at least 65 years old and be able to walk without assistance for inclusion. Subjects with cognitive impairment according to the Mini-Mental State Examination (MMSE)[14], neurological diseases, a history of recent fractures in the lower limbs, the presence of painful symptoms or edema in the lower limbs, orthopedic and/or rheumatic diseases in the hands, severe cardiorespiratory diseases or who were using medications such as systemic or inhaled corticosteroids, muscle relaxants and anti-inflammatory non-steroids were excluded.

Instrumentation

An isokinetic dynamometer (Biodex System 3 Pro®), which is an electromechanical instrument that provides objective, reliable and valid measures, was used to evaluate lower-limb muscle performance[15]. A Jamar® hydraulic hand dynamometer (Sammons Preston Rolyan, Bolingbrook, Illinois), which allows objective, reliable, safe and effective grip and pinch strength evaluation, was used to evaluate HG[16]. Habitual Walking Speed (HWS) and Fast Walking Speed (FWS) were measured with the Multisprint® kit for computerized evaluation of physical performance, which consists of reflectors and photoelectric cells that are connected to a computer running Multisprint® software[8,17]. LPA was obtained via self-reported performance on the Human Activity Profile (HAP) questionnaire, which is a valid, reliable instrument that has been translated and culturally adapted for the Brazilian population[18] and allows the classification of subjects as either active, moderately active or inactive. Measurements of weight and height for Body Mass Index (BMI) calculation were carried out with a calibrated scale, and CC was obtained with a tape measure[19,20].

Procedures

The subjects, who were all evaluated by the same examiner, were interviewed to verify clinical and demographic variables and to determine their cognitive (MMSE) and physical activity (HAP) levels[14]. Weight and body height were also evaluated. For CC measurement, which was performed bilaterally, the subject sat with his or her feet on the floor, forming right angles at the knee and ankle. The tape measure was placed around the calf without compressing the subcutaneous tissue, and moved in a distal-proximal direction to obtain the maximum circumference[5].

HG was measured isometrically for 6s in the dominant limb, in accordance with the recommendations of the American Society of Hand Therapy[21]. Subjects sat in a chair with a backrest and no armrests, with the shoulder of the dominant limb adducted and neutrally rotated, the elbow flexed at 90°, the forearm in neutral position and the wrist between 0° and 30° of extension and 0° to 15° of ulnar deviation. The handle was adjusted to the second-lowest grip position. The average of three trials was used for the score. A rest interval of 60s was given between trials and the subjects were verbally encouraged[16].

For the walking tests, the subjects wore their own everyday shoes. In the HWS they were instructed to walk at their normal pace, while in the FWS test, they were requested to walk as fast as safely possible without running. The test was performed on a 10m track, but the speed was only recorded from the middle 6m to avoid acceleration and deceleration bias. The average of two attempts was used for analysis[8,17].

The principles of isokinetic testing were observed during analysis of the muscle strength and power of the hip and knee flexors and extensors and the ankle plantar and dorsiflexors. All equipment was calibrated according to manufacturer instructions[22]. The order of evaluation was randomized by having the subject draw from among three opaque envelopes, each of which contained the name of a joint. Measurements were made bilaterally, beginning with the dominant limb, using concentric contractions at a constant angular velocity of 60°/s (five repetitions) for the ankle, 60°/s (five repetitions) and 180°/s (15 repetitions) for the knee and 60°/s (five repetitions) and 120°/s (15 repetitions) for the hip[23]. Ankle and knee joint tests were performed with the chair backrest inclined to 85°. For evaluation of the ankle, the knee was positioned at 30° of flexion and the axis of the ankle was aligned with the rotational axis of the dynamometer. The tested range of motion (ROM) was from 10° of dorsiflexion to 30° of plantar flexion. For evaluation of the knee, the rotational axis of the apparatus was aligned with the lateral epicondyle of the femur, the lever arm was positioned 3 cm above the lateral malleolus, and the tested ROM was 85° of knee flexion, starting from a 90° angle. The hip was tested while standing upright with the upper limbs supported in a stabilizer device[24]. The rotational axis was positioned above and anterior to the greater trochanter of the femur while the leg was in a neutral position, and the thigh was secured just above the popliteal fossa. The flexion-extension ROM of the hip was from 0° to 60°.

In this study the lower limb preferred for kicking and the upper limb preferred for writing were considered the dominant limbs.

Statistical analysis

Statistical analysis was performed with SPSS, version 15.0. The normality of data distribution was verified using the Kolmogorov-Smirnov test, with results presented as mean±standard deviation, range and percentage. Statistical significance was tested with analysis of variance (ANOVA) and Bonferroni's post hoc t-test. The Pearson correlation and analysis of sensitivity and specificity (ROC curve) were used to evaluate linearity. Exploratory factor analysis allowed, according to clinical and conceptual criteria, the creation of a smaller set of lower-limb muscle function variables from the original variables and permitted the use of sets of variables in the correlation test. The significance level was set at $(\alpha) = 0.05$.

Results

Characteristics of subjects

The demographic and clinical characteristics of the subjects are described in Table 1. When analyzed in relation to age groups, the only variable that showed a significant difference was body mass, with the 65-69 age group having a higher mean (75±13.3) than the 80+ group (64.4±9.4) (p=0.009). The other clinical and demographic variables were very similar, confirming homogeneity and ensuring comparability between groups.

Lower-limb muscle function and the clinical variables calf circumference, walking speed, handgrip strength and level of physical activity

Subjects at least 80 years old had significantly lower values than the 65-69 age group for dominant calf circumference (DCC) (p=0.02), non-dominant calf circumference (NDCC) (p=0.01), HWS (p=0.02), FWS (p<0.001), HG (p=0.01) (Table 2) and most bilateral measurements of average peak torque (APT) and average power (AP) of the hip, knee and ankle (Table 3 shows only measurements of the dominant leg). Most of the average CC, HWS, FWS, HG and muscle function measurements of the 70-79 age group showed no significant difference in relation to the 65-69 or 80+ groups.

However, in general, the mean comparison analysis of these clinical measures and of muscle function showed a linear tendency to decrease with advancing age.

Moderate correlations (p<0.05) were observed between most of the muscle function parameters and HWS, FWS and HG. CC was significantly correlated with the AP of hip and knee extensors (p<0.05), and HAP scores were correlated with the following groups: hip flexor (60°/s) and extensor torque (120°/s), knee flexors and extensors (60°/s and 180°/s), ankle plantar flexors (60°/s) and knee flexor power (Table 4). In the above-mentioned correlation analysis, the test power was increased from 78% to 99%.

Value of discriminatory handgrip strength to determine elderly people with or without reduction of lower-limb muscle function

Considering the findings of this study, it was hypothesized that the evaluated clinical measures could be used to identify early decline in lower-limb muscle function of the elderly.

Table 1. Subject Characteristics.

Variables	65-69 years (a)	70-79 years (b)	80+ years (c)	p-value
Women (n)	14	14	14	-
Men (n)	13	13	13	-
Age (years)†*	67.4 (±1.4)[bc]	73.9 (±2.9)	83.6 (±3.2)	<0.001
	(65-69)	(70-79)	(80-93)	
Right Dominant‡	100% (27)	100% (27)	96.3% (26)	0.363
Nutritional Supplement‡	7.4% (2)	18.5% (5)	18.5% (5)	0.415
Hormone Replacement Therapy‡	7.4% (2)	11.1% (3)	3.7% (1)	0.583
Regular Exercise Practice‡	63% (17)	40.7% (11)	55.6% (15)	0.250
Mass (Kg)†*	75 (±13.3)[c]	68.8 (±14.1)	64.4 (±9.4)	0.009
	(56.8-119.6)	(43.5-93.0)	(46.7-86.3)	
Length (m)†	1.63 (±0.09)	1.59 (±0.08)	1.58 (±0.09)	0.118
	(1.44-1.80)	(1.46-1.73)	(1.42-1.77)	
BMI (Kg/m²)†	28.3 (±4.8)	27 (±4.3)	25.7 (±2.8)	0.068
	(21.3-43.7)	(19.8-38.4)	(19.7-30.3)	
Level of Physical Activity‡				0.315
Inactive	0% (0)	3.7%(1)	3.7%(1)	
Moderately Active	32.0%(8)	40.7%(11)	48.1%(13)	
Active	68.0%(17)	55.6%(15)	48.1%(13)	

†mean (±standard deviation) and range (minimum-maximum); ‡percentage; *p<0.05; For each variable with means significantly different, the letter of the group with the lowest mean is shown next to the average of the group with the highest average.

Table 2. Comparison of clinical measurements of subject calf circumference, habitual and fast walking speed, hand grip and level of physical activity

Variables	Age Groups 65-69 (a) n=27	Age Groups 70-79 (b) n=27	Age Groups 80+ (c) n=27	ANOVA Effect Size‡	ANOVA p-value	Power
DCC(cm)†*	37.7(±3.6)[c] (32.4-48.5)	36.1(±3.6) (31.5-46.5)	34.9(±3) (29.8-41.2)	0.09	0.02	69.5%
NDCC (cm)†*	37.4(±3.9)[c] (32.3-50.0)	36.2(±3.5) (30.5-46.0)	34.6(±2.9) (30.0-39.9)	0.10	0.01	71.2%
HWS(m/s)†*	1.2(±0.2)[c] (0.8-1.6)	1.1(±0.2) (0.8-1.5)	1.1(±0.2) (0.7-1.7)	0.09	0.02	68.6%
FWS(m/s)†*	1.7(±0.3)[c] (1.2-2.4)	1.5(±0.2) (1.0-1.9)	1.4(±0.3) (0.8-2.1)	0.16	<0.001	91.9%
HG (Kgf)†*	31.8(±10.3)[c] (13.3-50.7)	28.3(±8.3) (6.8-41.7)	23.8(±7.5) (12.7-37.0)	0.12	0.01	80.1%
LPA†	81.3(±13.2) (54-94)	77.5(±11.4) (48-94)	74.6(±15.2) (42-94)	0.03	0.18	28.3%

‡*Eta Square.* †mean (±standard deviation) and range (minimum-maximum). *p<0.05 For each variable with significantly different means, the letter of the group with the lowest average is shown next to the average of the group with the highest mean. DCC=Dominant Calf Circumference; NDCC=Non-Dominant Calf Circumference; HWS=Habitual Walking Speed; FWS=Fast Walking Speed; HG=Handgrip strength; LPA=Level of Physical Activity.

Similar to osteoporosis diagnostics, the criterion of two standard deviations below average (in this case for muscle function) was used for the clinical classification of sarcopenia, in accordance with the proposal of Lauretani et al.[6]. Elderly people whose muscle function values were below this limit were classified as positive for sarcopenia. Upon applying this procedure to the three age groups, it was determined that two women (4.8%) and five men (12.8%) fell into this category, representing 9% of the total sample. Using the ROC curve (Figure 1), possible discriminatory values for predicting sarcopenia were investigated, including FWS, dominant CC, HG and HAP scores. After the sample had been segmented by gender, the results showed significant values only in women for the variable HG (p=0.03), suggesting a cutoff of 14.51 Kgf with 100% sensitivity, 92.5% specificity, a 96% positive predictive value and a 33% negative predictive value.

Table 3. Comparison of lower extremity muscle function parameters across age groups.

Variables	Age Groups			ANOVA		Power
	65-69 (a) n=27	70-79 (b) n=27	80+ (c) n=27	Effect Size ‡	p-value	
Average Peak Torque (Nm) – 60º/s						
Flx hip D*	83.6(±29.2)c	67.6(±23.8)	60.7(±23.4)	0.12	0.005	79.7%
Ext hip D*	62.3(±25)c	49.7(±21)	39.3(±21.9)	0.14	0.002	87.6%
Flx knee D*	51.4(±21.1)bc	36.5(±13.7)	30.4(±12.6)	0.23	<0.001	99.1%
Ext knee D*	114.3(±36.8)bc	92.4(±27.4)	75.4(±27.9)	0.22	<0.001	98.6%
Dflx ankle D*	16.8(±5.7)c	14.7(±5.4)	12.2(±5.7)	0.10	0.01	73.3%
Pflx ankle D*	47.2(±21.9)bc	33.6(±14.8)	24.9(±11.6)	0.23	<0.001	99.1%
Average Peak Torque (Nm) – 120º/s						
Flx hip D*	74.7(±24,2)c	63.1(±24)	52.8(±23.6)	0.12	0.005	80.3%
Ext hip D*	54.5(±26)c	44.4(±23.2)	30.7(±19.9)	0.15	0.001	89.9%
Average Peak Torque (Nm) – 180º/s						
Flx knee D*	31.1(±13.9)bc	23.4(±9.8)	18.9(±8.8)	0.17	<0.001	94.8%
Ext knee D*	67.7(±22.4)bc	53.2(±19.2)	45.3(±16.2)	0.19	<0.001	96.9%
Average Power (W)						
Flx hip D*	83.6(±30.9)c	67.4(±27.2)	55.6(±25.4)	0.14	0.002	88.2%
Ext hip D*	47.6(±27.2)c	39.5(±24)	24.1(±17.4)	0.15	0.001	90.0%
Flx knee D*	43.2(±23.3)bc	30.7(±16.5)	23.8(±13.9)	0.16	0.001	93.1%
Ext knee D*	109.9(±41.2)bc	82.7(±33.6)	68.9(±28.7)	0.20	<0.001	97.5%

Mean (±SD). *p<0.05. For each variable with significantly different means, the letter of the group with the lowest average is shown next to the average of the group with the highest mean. ‡*Eta Square*. Flx=flexors; Ext=extensors; Dflx=Dorsiflexors; Pflx=plantar flexors; D=dominant limb.

Table 4. Correlations between lower extremity muscle function and clinical measurements of body mass index, calf circumference, walking speed, handgrip strength and level of physical activity.

Variable Groups	DCC	NDCC	HWS	FWX	HG	LFA
Body Mass Index (BMI)	0.74**	0.77**	-0.13	-0.11	0.01	-0.14
Hip flx torque (60º/s)	0.19	0.15	0.48*	0.62***	0.63***	0.45***
Hip ext torque (60º/s)	0.14	0.12	0.43*	0.61***	0.61***	0.34
Hip flex torque (120º/s)	0.06	0.04	0.24	0.35	0.41*	-0.09
Hip ext torque (120º/s)	0.2	0.16	0.52**	0.64***	0.62***	0.45*
Hip flex power	0.13	0.11	0.39*	0.61***	0.52**	0.34
Hip ext power	0.49*	0.44*	0.46*	0.62***	0.68***	0.36
Knee flex torque (60º/s)	0.18	0.14	0.57**	0.68***	0.67***	0.52**
Knee ext torque (60º/s)	0.15	0.12	0.56**	0.73***	0.72***	0.51**
Knee flx torque (180º/s)	0.16	0.12	0.53**	0.65***	0.59**	0.51**
Knee ext torque (180º/s)	0.21	0.16	0.57**	0.70***	0.69***	0.46*
Knee flx power	0.37	0.32	0.47*	0.62***	0.62***	0.44*
Knee ext power	0.48*	0.42*	0.48*	0.63***	0.70***	0.36
Ankle pflx torque (60º/s)	0.10	0.10	0.52*	0.65***	0.54**	0.39*
D Ankle Dflx torque (60º/s)	0.09	0.08	0.32	0.47*	0.48*	0.28
ND Ankle Dflx torque (60º/s)	0.21	0.21	0.41*	0.55**	0.59**	0.29

Data represent the *Pearson* correlation coefficient (r). *p<0.05; **p<0.01; ***p<0.001. Flx=flexors; Ext=extensors; Dflx=Dorsiflexors; Pflx=plantar flexors. D=dominant limb; ND=non-dominant limb. DCC=Dominant Calf Circumference; NDCC=Non-Dominant Calf Circumference; HWS=Habitual Walking Speed; FWS=Fast Walking Speed; HG=Handgrip strength; LPA=Level of Physical Activity.

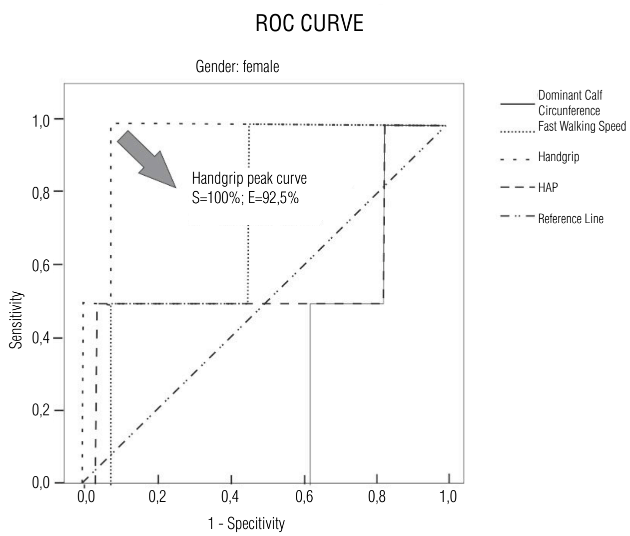

Figure 1 - ROC Curve: Female
Source: research data

PPV: 96%
NPV: 33%
Area Under the Curve: 0,96

HAP=Human Activity Profile.

Figure 1. ROC Curve plots showing how measures of hand grip allow the identification of participants with reduced muscle function.

Discussion

In this study, the parameters of lower-limb muscle strength and power in advancing age and the possible clinical measures that may be correlated with them were investigated in community-dwelling elderly. Although such an association has been investigated previously[6,12,13,25], there have as yet been no published studies involving the evaluation of the three lower limb joints.

The age groups involved in the study were divided equally among the sexes, the subjects were normally physically active, had few comorbidities and had similar clinical-demographic profiles, which is relevant since the literature shows that gender, LPA, dominance, the use of nutritional supplementation and hormone replacement therapy may influence muscle performance[5,13,25-28].

Regarding the variables obtained by isokinetic dynamometer testing, a significant reduction in APT and AP of the flexor and extensor muscles of the hip, knee and ankle was observed with increasing age, especially after the age of 80, which corroborates the results of previous studies[6,25]. The percentage of AP loss (40%) between the 65-69 and 80+ age groups was higher than that of APT (35%), which corroborates the findings of Lauretani et al.[6]. Therefore, tests that measure power (i.e., the ability of muscle to exercise a great amount of force at high speeds) via activities such as climbing stairs and rising from a chair should be considered an important part of the clinical routine for geriatric patients, since power impacts the performance of basic and instrumental activities of daily living[11,12,29].

CC showed a tendency to decrease with advancing age, becoming particularly significant in older age groups (80+ years), which corroborates previous findings[6,19,20]. However, no significant associations were found between most of the lower-limb APT and AP values and CC in the evaluated subjects. The absence of a significant association between muscle function and CC may indicate a dissociation between muscle mass and strength, which has been previously documented in studies showing that the reduced strength observed in the elderly is much greater than the concomitant decrease in muscle mass[26,27]. It may also be that CC was influenced by the presence of subcutaneous fat (confounding factor) in overweight subjects and possibly by sarcopenic obesity, considering that CC showed a moderate positive correlation with BMI (Table 4)[30,31]. Thus, the clinical evaluation of CC may be difficult to interpret and should be undertaken with caution, since weakening initially occurs with an apparent maintenance of muscle mass, and measures may also reflect differences in the compressibility of skin and subcutaneous tissue in overweight or obese subjects.

Regarding functional mobility, HWS and FWS values agreed with the average speed for individuals over 60 years of age reported in the literature, which varies from 0.60 to 1.45 m/s for HWS and from 0.84 to 2.1 m/s for FWS[32]. However, the results of this study approached the highest values, which may have been due to methodological differences such as the techniques used, the length of the runway or subject LPA. Regarding the observed changes in walking speed among the age groups, which confirmed the results of previous studies[6,28], the HWS and FWS of subjects at least 80 years old were significantly slower than those of 65-69 year-olds. Additionally, a significant association between FWS, HWS and the evaluated muscle function parameters was found. Nevertheless, the correlation between muscle power and strength and FWS was stronger, which agreed with previous studies[10,11,33,34]. These results demonstrate the importance of measuring FWS, an objective measure that requires from 2 to 5 min and has been well-accepted by professionals and patients, in the routine clinical evaluation of active, community-dwelling elderly patients. It should also be considered that impaired mobility is associated with a reduction of muscle strength and power, disability and dependency in performing activities of daily living[8,10,32,35].

In this study, the elderly subjects' LPA, a variable that influences muscle function[25], showed a linear tendency to decrease with advancing age, although there were no significant differences among age groups. Furthermore, correlations between LPA and muscle function variables were low, which contradicts other studies[13,36]. The fact that elderly subjects of different age groups showed similar LPA may have been due to either their profile as community-dwelling, independent, active and self-selected[25], or to sample size insufficiency for detecting intergroup differences for this variable, since the study power for such analysis was low (28.3%).

Confirming previously published results[6,7,37], this study sample showed a decrease in HG with aging and moderate correlations between HG and most parameters of muscle function of the three joints of lower limbs. Based on the observed correlations, we sought to establish a cutoff point for tracking elderly patients at risk for reduced lower limb muscle strength and power and found 14.51 Kgf as a good cutoff point for use in clinical practice in elderly women. This value is low compared to the 20 Kgf proposed by Lauretani et al.[6] for diagnosing mobility loss and sarcopenia, and may reflect methodological and sampling differences. However, our results demonstrated that HG is the variable that best predicts an overall reduction in muscle function, and it warrants investigation in future studies. However, the results of HG tests with elderly patients should be interpreted cautiously due to the frequency of diseases affecting the hands, such as rheumatoid arthritis and osteoarthritis, which would reduce the association between HG and lower-limb muscle function. Thus, affected segments of the elderly population would need specific measurements of functional mobility and global muscle function[6].

It is acknowledged that both muscular and functional breakdown accelerate after the age of 70, when muscle weakness and atrophy seem to evolve at a faster pace[27,29]. The results of this study indicated that reductions in body weight, walking speed, HG, CC, APT and AP were significantly greater after 80 years. As has been demonstrated in other studies[27,29], our findings suggest that the acceleration of muscle function loss can be postponed in healthy and independent community-dwelling elderly.

Due to the cross-sectional nature of this study, inferences regarding the changes in muscle function parameters, functional mobility and LPA with advancing age are restricted. Nevertheless, the study design and correlation analysis provide an explanation of elderly performance and allow the formulation of objectives for improving clinical evaluation and intervention.

Conclusion

This study found an association between lower-limb muscle function, HG and FWS, demonstrating a reduction in these parameters with advancing age, and suggested the possibility of screening for lower-limb muscle function through HG. Thus, the clinical implications of this study are linked to the importance of preventing the functional and muscle decline and decreases in LPA that occur with aging and the possibility of optimizing programs of lower-limb strength training for the elderly. Among community-dwelling elderly with a high activity level, the tracking and identification of small functional changes through simple clinical measures, such as HG, may promote early intervention and prevent disability. However, further investigation is needed to ready such a tool for the routine clinical evaluation of geriatric patients.

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