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Original article

Anthropometric and demographic predictors of handgrip strength and lean mass quality in hospitalized individuals

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SUMMARY

Background and aim: Low strength and/or lean mass quality are associated with higher hospitalization and mortality. The aim of this study was to evaluate the main demographic and anthropometric predictors of strength and lean mass quality in hospitalized patients.

Methods: We evaluated 136 patients (18–86 years) of both sexes, admitted in a public hospital. Waist circumference (WC) was measured using an inelastic tape, lean mass (LM) was assessed by bioimpedance, and handgrip strength (HGS) was performed using a dynamometer. Lean mass quality (HGS/LM) was also calculated.

Results: We noted that LM predicted 33.1% of HGS, whereas WC was not associated with HGS. Evaluating LM and WC in the same statistical model, WC ($\beta = -0.249$, $p = 0.001$) increased the prediction of HGS by 4.7% when compared to LM alone. Accessing LM, WC, age, and sex in the same model an increase in the prediction of HGS by 7.3% was noted when compared to LM alone, but only LM and sex were significant. In addition, WC predicted the lean mass quality by 4% ($\beta = -0.205$, $p = 0.016$) and when WC, sex, and age were placed in the same model; WC ($\beta = -0.172$, $p = 0.035$) and sex ($\beta = 0.332$, $p < 0.001$) explained the variations in lean mass quality by 15%.

Conclusion: The main predictor of lower HGS was lower LM, whereas sex showed a low association. Furthermore, although a low association was found, higher abdominal obesity and sex predicted lower lean mass quality.

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1. Introduction

Handgrip strength (HGS) is a validated and feasible method for muscle strength measurement and can be used in healthy or hospitalized patients as a possible tool for clinical purpose [1]. This method may be performed in ambulatory or hospitalized individuals [2] and is associated with an increased risk of hospitalization [3,4], hospital length stay [5,6], decline in cognition [7], functional status mobility [7], complications in hospitalized individuals [2], hospitalization costs [8], and mortality [1,3,9].

In addition to HGS evaluation, the measurement of muscle quality (strength to muscle mass ratio [10]) appears as a complementary evaluation of muscle or lean mass (LM) function [11]. It is known that although the amount of muscle mass is associated with strength, they do not seem to present a linear correlation [12]. Therefore, the measurement of HGS/LM ratio can provide important information of LM function independently of the amount of LM. Despite it has been studied in several populations [13,14], to the best of our knowledge, the LM quality has not yet been evaluated in general hospitalized individuals.

Strength and LM quality can be influenced by some factors, such as LM quantity, abdominal adiposity, age, and sex [1,10,15–23]. In this way, it is essential to understand the main predictors of HGS and LM quality in hospitalized patients for future interventions before a possible hospital admission or after hospital discharge, to prevent future problems during hospitalization. Considering that LM and abdominal obesity are modifiable factors, to know the power of prediction of these factors on strength and LM quality could be an important information to prevent future problems

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during a hospital admission. Thus, the aim of this study was to evaluate the main anthropometric and demographic predictors of HGS and LM quality in hospitalized patients. We hypothesized that lower LM and higher abdominal adiposity could be the main predictors of low HGS. Additionally, we also hypothesized that high abdominal adiposity could be associated with lower LM quality.

2. Methods

2.1. Subjects

A cross-sectional study was conducted in a convenience sample of a public hospital in Uberlandia, Minas Gerais, Brazil. The study population was composed of all individuals admitted in the hospital, who were able to join to the study at the period of evaluation; and we included solely the patients who were able to walk due to be possible to evaluate anthropometric measurements. Bedridden patients were excluded due to be not possible to evaluate weight and height. Thus, 136 hospitalized patients (121 Caucasians and 15 were blacks), older than 18 years (between 18 and 86 years) of both sexes, signed a free and informed consent and the research was approved by the Ethics Committee of the Federal University of Uberlandia (protocol 069123/2013). The evaluations were carried out by three trained nutritionists and were conducted between March to June of 2016. The number of participants required for the current study was calculated using G*Power software (version 3.0.1). We used an *a priori* power test, alpha level of 0.05, a power of 95%, a large effect size of 26% ($R^2 = 0.26$) and four variables in the multiple regression. A minimum sample size of 58 subjects was estimated.

2.2. Anthropometric assessment

Weight, height, body mass index (BMI), and waist circumference (WC) were measured. The current weight was obtained using a portable balance (Líder®, Brazil), with maximum capacity of 200 kg. Height was measured using a portable stadiometer (Welmy®, Brazil) and BMI was calculated as weight divided by height squared and classified according to WHO [24] for adults and Lipschitz [25] for older adults. Waist circumference was measured at the midway point between the last rib and the iliac crest with a inelastic anthropometric tape (Sanny®, Brazil)) [26].

2.3. Handgrip strength

Handgrip strength was performed with a hydraulic hand dynamometer (Jamar®, UK), adopting the unit of measure in kilograms (kg). The scale of HGS was from 0 to 90 kg and progressed each two kilograms. The patient was standing or lying on the bed with the arm adducted and neutral rotation with the elbow flexed to 90°, with forearm and wrist in neutral rotation. The unit's rod was placed between the second phalanges of the fingers (index, middle and ring). In the test, the needle was placed in the neutral position (zero). At the evaluator's voice command, the patient should hold the power utmost to bring the two device rods. Three measurements were performed in the dominant hand with a rest interval of 20 s and the higher value was considered [27]. Handgrip strength was classified as inadequate when the values were <30 kg for men and <20 kg for women [28].

2.4. Body composition and lean mass quality

Lean mass and body fat were estimated by multiple frequency bioimpedance (Biodynamics®, model 450, USA). The evaluation occurred in the morning, with participants fasted for at least 8 h and the patients should be in a supine position 5 min before the measurement. The ornaments were previously removed and the use of metal pins and cardiac pacemaker were consideredas exclusion criteria. Four electrodes were used for the evaluation, being positioned two electrodes in upper and two electrodes in lower limbs on the right side of the body. Participants were instructed to not consume caffeine within 24 h before the procedure in order to avoid any changes in diuresis. All individuals should had presented the total body water/LM between 69 and 75% to be considered with an adequate hydration for a reliable analysis, according to the manufacturer's recommendations. The resistance value was used to estimate the LM by Segal et al. equation [29]. Body fat was calculated by subtracting body weight by fat-free mass estimated by bioimpedance. Lean mass quality was calculated by HGS (kg) to LM (kg) ratio.

2.5. Statistical analysis

The tests were performed using STATISTICA 6.0 software. The data were described as mean ± SD. The sample normality was tested by Shapiro–Wilk test and for comparison of individuals, according to HGS classification, student *t*-test (unpaired) was used. To evaluate the main predictors of handgrip strength and LM quality, standard linear regression analysis was performed. For HGS predictors, we included demographic and body composition variables (sex, age, LM, and WC) in four models, whereas model 1 was constituted by LM (kg); model 2 by WC; model 3 by LM and WC; model 4 by LM, WC, age, and sex. For LM quality predictors, we performed 2 statistical models, whereas model 1 was constituted by WC; and model 2 by WC, sex, and age. For sex variable, women were classified as 0 and men as 1. The *post hoc* power analysis using effect size, alfa error, total sample size, number of tested predictors, and total number of predictors was calculated for this study. We adopted a significance level of $p < 0.05$.

3. Results

Of the 136 patients evaluated, 62.5% (n = 85) were male and 37.5% (n = 51) were female. Regarding the nutritional status classified by BMI, it was observed that 5.14% of the patients (n = 7) were underweight, 40.44% (n = 55) normal weight, 38.97% (n = 53) overweight, 9.55% (n = 13) class I obesity, 2.20% (n = 3) class II obesity, and 1.47% (n = 2) class III obesity.

The causes of hospitalization were cancer (n = 50; 36.76%), digestive system diseases (n = 28; 18.38%), cardiovascular system diseases (n = 20; 14.70%), urinary system diseases (n = 9; 6.61%), respiratory system diseases (n = 7; 5.14%), endocrine system diseases (n = 6; 4.41%), genetic diseases (n = 5; 3.67%), dermatological (n = 3; 2.20%) and orthopedic diseases (n = 3; 2.20%), nervous system diseases (n = 2; 1.47%), nutritional disorders (n = 1; 0.73%), infectious (n = 1; 0.73%), and trauma (n = 1; 0.73%).

The patients with low values of HGS were older and presented lower weight, LM, and LM quality than patients with adequate HGS. No differences were observed between groups for BMI, body fat, WC, and height (Table 1).

To determine the main anthropometric and demographic parameters of HGS, we performed four statistical models in regression analysis. We noted that LM predicted 33.1% of HGS ($R^2 = 0.331$; $p < 0.001$) (Model 1), whereas WC was not associated with HGS ($R^2 = 0.004$; $p = 0.436$) (Model 2). Evaluating LM and WC in the same statistical model (Model 3), WC ($\beta = -0.249$, $p = 0.001$) increased the prediction of HGS by 4.7% ($R^2 = 0.378$; $p = 0.001$), when compared to LM alone. Accessing LM, WC, age, and sex together (Model 4) an increase in the prediction of HGS by 7.3% ($R^2 = 0.404$) was noted when compared to LM alone, but only LM and sex were significant (Table 2).

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