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Association between peripheral muscle force and muscular respiratory strength in hospitalized elderly

Associação entre força muscular periférica e força muscular respiratória em idosos hospitalizados

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RESUMO | INTRODUÇÃO: A sarcopenia é uma síndrome caracterizada por perda progressiva e generalizada de massa e força do músculo esquelética, bem como possivelmente da musculatura respiratória com risco de desfechos adversos, como declínio da funcionalidade, má qualidade de vida e morte. O risco de complicações respiratórias e infecções na população idosa é elevado, o que pode ser devido, em parte, as alterações da força do diafragma. **OBJETIVO:** Avaliar a associação entre força muscular periférica e força muscular respiratória em idosos hospitalizados. **MÉTODOS:** Trata-se de um estudo realizado em um hospital público na cidade de Salvador, Bahia. As variáveis primárias mensuradas foram medidas antropométricas, força de preensão palmar, força muscular respiratória através da aferição da pressão inspiratória máxima (PImáx), velocidade de marcha e presença de tabagismo. As variáveis secundárias extraídas a partir de dados de prontuário foram idade, gênero, diagnóstico médico admissional, perfil clínico admissional (clínico ou cirúrgico), tempo de internação no momento da coleta e índice de comorbidades de Charlson. Para avaliação entre as variáveis da FPP e força muscular respiratória foi utilizado a análise da correlação de Pearson. **RESULTADOS:** Dos 95 idosos avaliados, 73,7% era do sexo masculino, 89,5% tinham internação por motivo cirúrgico (40,2% cirurgias abdominais; 30,4% cirurgias urológicas; 16,3% amputações; 13,1% outras cirurgias), IMC 24,5 ± 4,1Kg/m2. A média de idade foi 68,1±6,1 anos, força de preensão palmar 31,3 ± 9,1Kgf e PImáx -77,5±33,2 cm H2O. O tempo para avaliação inicial foi de 4,3 ± 3,1 dias após internação hospitalar. O índice de comorbidades de Charlson foi de 3,6 ± 1,89 e a pontuação do mini-exame do estado mental foi 22,9±7,22. A correlação entre a força de preensão palmar e a força muscular respiratória foi moderada (R=-0,439 e valor de p= 0,001). **CONCLUSÃO:** Existe relação entre FMR e FMP, bem como a FMR pode predizer dinapenia. Apesar disso, recomenda-se que a avaliação da FMR e FMP sejam feitas de forma individualizada para um posterior direcionamento do plano terapêutico, já que esta relação foi apenas moderada.

PALAVRAS-CHAVE: Respiração. Idosos. Força muscular.

ABSTRACT | INTRODUCTION: Sarcopenia is a syndrome characterized by the progressive and widespread loss of skeletal muscle mass and strength, which can be used as a life-threatening respiratory massage, such as decline in function, poor quality of life, and death. The risk of respiratory and control complications in the elderly population is one that may be due to a change in the strength of the diaphragm. **OBJECTIVE:** To assess the association between peripheral muscle strength and respiratory muscle strength in hospitalized elderly. **METHODS:** this is a study carried out in a public hospital in Salvador, Bahia. The primary variables measured were anthropometric measurements, palmar grip strength, respiratory muscle strength through maximal inspiratory pressure (MIP), gait velocity and presence of smoking. The secondary variables extracted from medical records were age, gender, admission medical diagnosis, admission clinical profile (clinical or surgical), length of hospital stay at time of collection and Charlson comorbidities index. The Pearson correlation analysis was used to evaluate the PPF variables and respiratory muscle strength. **RESULTS:** Of the 95 elderly patients evaluated, 73.7% were male, 89.5% were hospitalized for surgical reasons (40.2% were abdominal surgeries, 30.4% were urological surgeries, 16.3% were amputations, 13.1% were other surgeries), BMI 24.5 ± 4.1 kg / m2. The mean age was 68.1 ± 6.1 years, palmar grip strength 31.3 ± 9.1 Kgf and PImax -77.5 ± 33.2 cm H2O. The time for initial evaluation was 4.3 ± 3.1 days after hospital admission. The Charlson comorbidities index was 3.6 ± 1.89 and the mini-mental status score was 22.9 ± 7.22. The correlation between palmar grip strength and respiratory muscle strength was moderate (R = -0.439 and p = 0.001). **CONCLUSION:** There is a relationship between FMR and FMP, and FMR can predict dynapenia. Despite this, it is recommended that the evaluation of FMR and FMP be made in an individualized way for a subsequent direction of the therapeutic plan, since this relationship was only moderate.

KEYWORDS: Breathing. Elderly. Muscle strength.

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Introduction

Sarcopenia is a syndrome characterized by progressive and widespread loss of mass and strength of skeletal muscle, with risk of adverse outcomes, such as decline in functionality, poor quality of life and death[1].

According to the European Working Group on Sarcopenia in the Elderly (EWGSOP), it is recommended to use low muscle mass and low muscle function (muscle strength or physical performance) as criteria for defining the diagnosis of sarcopenia. Staging can guide the clinical management of this condition and can be classified as pre-sarcopenia, sarcopenia or severe sarcopenia[3].

Dinapenia can be defined as the loss of muscle strength associated with age that is not caused by neurological or muscle diseases, predisposing the elderly to an increased risk of functional limitations and mortality[5]. The factors that contribute to dinapenia are probably multifactorial and include aspects of the nervous and muscular systems. Recent longitudinal data suggest that the progressive loss of muscle strength is 2-5 times greater than the loss of muscle mass with aging[6].

Regarding the prevalence of sarcopenia, according to the EWGSOP criteria, in the elderly in the community, this percentage was 1 to 29%, according to data from a recent systematic review[7]. In hospitalized elderly patients, the reported rate varied between 21.8% to 26%[9]. There is a gap in the literature regarding the prevalence of this percentage in relation to dinapenia, justified by the lack of consensus in the standard definition of the term. Only one study showed that the most prevalent condition in the elderly population is dinapenia, when compared to sarcopenia and sarcodinapenia, with a rate of 34.4% in women and 25.8% in men[10].

Recently it has been shown that aging is also associated with loss of strength in the diaphragm muscle, reducing ventilatory and strength capacity11. Muscle changes associated with age affect respiratory muscle function, with a significant 25% reduction in the diaphragm strength of the elderly when compared to young adults[12-13]. For this reason, the development of respiratory complications is common[14], being the most prevalent cause of death in this population[15]. The reduction in strength of the diaphragm is due to the selective atrophy of type IIx and / or IIb muscle fibers, while type I and IIa fibers are preserved16. These individuals have increased proteolysis of the elastic fiber (elastin) and increased collagen in the lung parenchyma, as well as increased stiffness of the rib cage, favoring a mechanical disadvantage of the respiratory muscles and may, in the long run, generate weakness in the respiratory muscles[17]. As dinapenia is still a recent topic in the scientific literature and knowing the scarcity of studies demonstrating the association between peripheral muscle strength and respiratory muscle strength in hospitalized elderly, the present study aimed to assess the correlation between peripheral muscle strength and respiratory muscle strength, as well as to evaluate the accuracy of respiratory muscle weakness to predict dinapenia in hospitalized elderly.

Methods

Study design and population

This is an observational study on the association of respiratory muscle strength and peripheral muscle strength in hospitalized elderly, conducted in a general public hospital in Salvador, Bahia, from October 2017 to September 2018. Elderly people aged 60 years or over, who had a body mass index (BMI) <30 kg / m2 were included; hospitalization period between the first and the fifth day of hospitalization; ability to understand and execute simple external commands, such as: raising the leg, opening the eyes and other simple verbal commands, absence of use of vasoactive and / or inotropic drugs and ability to walk without the use of orthoses or assistance from the physiotherapist(as released) expressed in medical records by the attending physicians).

The elderly who had pain, dyspnea, disabling cardiorespiratory changes or previous respiratory diseases were excluded from the study. In addition, the study excluded elderly people who, during the tests, had precordialgia, peripheral oxygen saturation (SpO_2) ≤90%, dizziness, pallor, nausea, sweating, palpitations, pre-syncope, dyspnea, loss of invasive devices or fall.

Participants were recruited after approval by the Ethics Committee, under the CAAE 54038316.0.0000.5028 protocol, respecting all ethical principles and resolution 466/12. A daily evaluation of the medical records was carried out in order to select individuals admitted to the hospital and who were within the inclusion criteria proposed by the study over the period.

Primary and secondary variables

The primary variables measured in this study were anthropometric measurements (body weight and height), mini-examination of mental status (MMSE), handgrip strength and respiratory muscle strength. Secondary variables, on the other hand, were extracted from medical record data, including age, gender, medical admission diagnosis, admission profile (clinical or surgical), length of stay at the time of collection, and Charlson's comorbidities index.

BMI was obtained by dividing body weight in kilograms by height squared in meters. The values found were classified according to data from the World Health Organization: low weight (BMI <18.5), eutrophy (BMI between 18.5-24.99), overweight (BMI between 25-29.99) and obesity (BMI ≥30.00)[18]. Cognitive function was assessed using the mini-mental state examination (MMSE), which quantifies the various cognitive functions, with a score ranging from 0 to 30 points[19].

The measurement of peripheral muscle strength was performed using the Saehan hand dynamometer (Saehan Corporation, 973, Yangdeok-Dong, Masan 630-728, Korea). Participants were instructed to sit in a chair, with elbows at 90° and to perform maximum strength on the handgrip dynamometer20. Three measurements were performed with an interval of one minute between them, the largest measure being considered for further analysis. The criterion for defining muscle weakness and / or dinapenia was handgrip strength of less than 20 kgf in women and 30 kgf in men[21].

Direct inspiratory muscle strength was measured using a Wika CL 1.6 manuvacuometer. The individuals were instructed to sit with hips flexed at 90 ° and feet flat on the floor and instructed on how to perform the techniques. The manuvacuometer was coupled to the one-way valve expiratory branch and the same coupled to the mouthpiece[22]. A slow and complete exhalation was requested until the residual volume and, then, a deep inhalation until the total lung capacity and immediately after a maximum expiration until the residual volume, under the evaluator's commands. The measurement obtained was the highest value found of three measurements, with a variation of less than 5 points and an interval between them of 1 minute, recommended by the American Thoracic Society[23].

To quantify the level of disease severity, Charlson's comorbidity index was collected in the first 24 hours of admission. The Charlson index is a score composed of twenty clinical conditions selected empirically based on the effect on the prognosis of a cohort of patients admitted to a general medical service in the United States[24]. Their score ranges from 0 to 6, for some clinical conditions, and every decade, from 50 years on, a weight is added to the index. The higher the score obtained, the greater the severity and risk of death.

Statistical analysis

The results were described in means and standard deviation for the numerical variables and in percentages for the categorical variables. Pearson's correlation analysis was used to assess the correlation between the palmar pension strength and respiratory muscle strength variables. To assess the accuracy of respiratory muscle strength to predict dinapenia, the ROC (Receiver Operator Characteristics) curve and its respective accuracy were described, with a value of $p < 0.05$ being considered significant. The statistical analysis and the database were performed using the SPSS program, v10.0 (Chicago, Illinois, USA).

Results

The sample consisted of ninety-five hospitalized elderly people, with a mean age of 68.13 ± 6.05 years, with a predominance of males (73.7%) and the prevalent surgical admission profile (89.5%). The most prevalent reasons in this sample were postoperative abdominal surgery (38.9%) and postoperative urological surgery (29.5%), followed by postoperative for amputations (15.8%), postoperative cardiac (1.1%), gastrointestinal diseases (7.4%), vascular disease (1.1%), urinary tract disease (3.2%) and others (3.2%). The mean values of peripheral muscle strength and respiratory muscle strength found in this study were 31.3 ± 9.1 kgf and -77.6 ± 33.33 cm H20), respectively. The sample's descriptive data are contained in Table 1.

Table 1. Descriptive chracteristics of the sample of 95 hospitalized elderly included in the study

	Mean / SP	N / %
Age, years	68.13±6.05	
BMI, kg/m²	24.51±4.08	
Gender		
Male		70 (73.7)
Female		25 (26.3)
Length of stay during collection, days	4.37±3.17	
Admission profile		
Clinical		9 (9.5)
Surgical		85 (89.5)
Missing		1 (1.1)
Charlson Index	3.62±1.89	
MMSE	22.90±1.80	
Strength on the handgrip	31.34±9.09	
MIPmax	-77.55±33.20	

IMPmax: maximum inspiratory pressure; PO: postoperative.
There was a moderate correlation between peripheral muscle strength and respiratory muscle strength (R = - 0.439; p value = 0.001) in figure 1.

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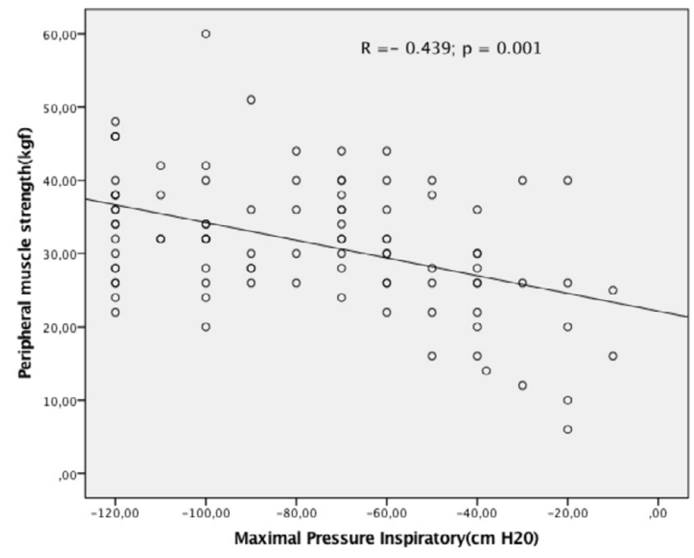
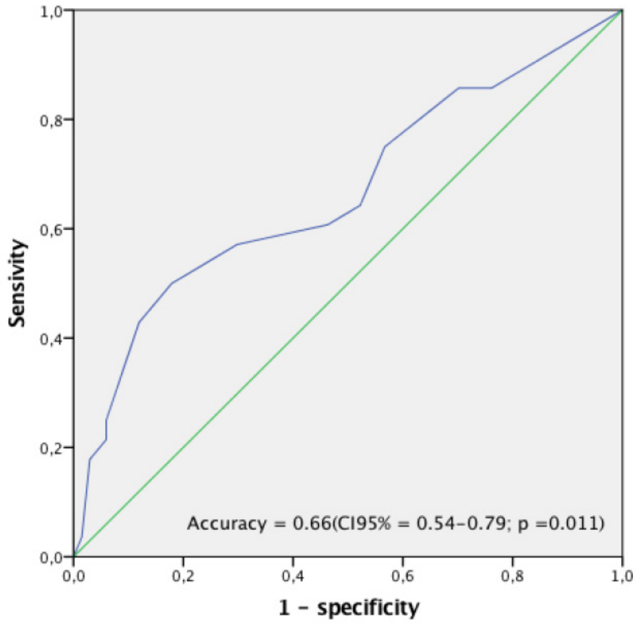
Figure 1. Correlation between peripheral muscle strength and respiratory muscle strength in the sample of hospitalized elderly. (N = 95)



In the analysis of the capacity of respiratory muscle strength to predict dinapenia, moderate accuracy was also observed (Accuracy = 0.66; 95% CI = 0.54-0.79; p = 0.011) in figure 2.

Figure 2. Accuracy of respiratory muscle strength to predict dinapenia in the sample of hospitalized elderly. (N = 95)



Discussion

The results of this study showed that there is a moderate correlation between peripheral muscle strength and respiratory muscle strength in hospitalized elderly people, in addition to moderate accuracy in the capacity of respiratory muscle strength to predict dinapenia, which reinforces a possible association between respiratory and peripheral muscle.

The data in the present study are in agreement with other studies[25-27,34], which identified that peripheral muscle strength also had a moderate and positive correlation with inspiratory muscle strength. The authors also emphasize that sarcopenia can cause a decrease in peak cough flow, bringing possible respiratory complications with aging[25,26]. These studies suggest that there is a significant relationship between respiratory muscle strength, especially inspiratory muscles, and limb muscle strength and muscle mass in the elderly.

The correlation between handgrip strength and maximum inspiratory pressure (MIP) appears to be strong in healthy individuals (r = 0.76)[28], and MIP can be predicted with 80% accuracy by important parameters, such as sex, BMI and handgrip strength. In addition, there was also a positive correlation between inspiratory muscle strength (MIP) with peripheral muscle strength and with sarcopenic indexes in healthy young adults[29], while the correlation in the present study was moderate (r = 0.439). However, these results may be in conflict with this study, since the population included was hospitalized elderly, without any previous lung disease and without important functional limitations.

In addition, handgrip strength was also positively correlated with lung function in a dose-dependent manner[30] in the elderly without previous lung disease or chronic diseases. The authors argue that the timely detection of reduced handgrip strength can be useful in assessing possible impairment of lung function.

As sarcopenia is a generalized process, it is believed that there is also impairment of the respiratory muscles, which possibly results in impaired ventilation, reduced mobility and loss of functional independence. Recently, sarcopenia of the diaphragm muscle in elderly rats has been demonstrated[31]. The authors evaluated young (5 months), elderly (23 months) and “BubR1h / h (accelerated aging) mice and observed that aging is associated with loss of strength in the diaphragm muscle, represented by reductions in muscle fiber strength and size type I or IIa. The presence of respiratory muscle sarcopenia is probably a central factor for the development of respiratory failure and reduced airway clearance among older individuals.

The sarcopenia of the diaphragm muscle (DIAm) has not been well characterized. DIAm is the main inspiratory muscle and knowledge of sarcopenia DIAm is important to establish the effects of aging on respiratory function. The maximum transdiaphragmatic pressure measured during an effort is approximately 25% lower in healthy elderly people when compared to young males[12], suggesting that muscle changes related to aging may predispose muscle fatigue during strenuous breathing efforts.

In this study, there was moderate accuracy in the capacity of respiratory muscle strength to predict dinapenia. The reduction in respiratory muscle strength in the elderly without previous lung disease is also associated with loss of mobility, regardless of peripheral muscle strength and level of physical activity[32]. Authors also identified that the reduction in respiratory muscle strength is associated with worse physical performance in the elderly, regardless of peripheral muscle mass and strength[33]. It is suggested, therefore, that the maximal inspiratory pressure (MIPmax) data may be useful for prognostic purposes in the elderly population.

Peak expiratory flow (PEF) is determined by the strength of the respiratory muscles. However, research on the use of PEF as a measure of sarcopenia is limited and is not recommended as a measure of respiratory muscle strength alone[3]. Studies related to respiratory muscle strength and sarcopenia used the maximum inspiratory pressure (MIPmax) as a measure, with the mean reference values found in healthy elderly individuals being 57 cmH20 for women and 83 cmH20 for men. The MIPmax value found in the present study was 77.55 ± 33.20, being similar to the result of other studies[34]. The values described in the literature are scarce, but authors have identified a cut-off point for MIPmax of moderate precision, in elderly males, of -55.6 cmH20[34]. Recently, a study showed cutoff points for the maximum inspiratory pressure between ≤-55cmH20 and ≤-45cmH20 for men and women, respectively[35]. The authors also showed that these values are associated with the diagnosis of sarcopenia in the elderly.

Thus, we realized that the reduction in peripheral and respiratory muscle strength can lead to increased economic health costs, such as longer hospital stays and mortality, in addition to rehabilitation costs and the need for institutional care at discharge. This study had some limitations, such as the fact that individuals in this sample did not present respiratory and peripheral muscle weakness and these data may reduce the external validity for other populations, such as the elderly who have reduced strength. Future studies are needed to assess strength variables for a longer time and with a greater number of elderly individuals.

Conclusion

There is a relationship between RMS and PMS, and RMS can predict dinapenia. In spite of this, it is recommended that the evaluation of the RMS and PMS be done individually for a later direction of the therapeutic plan, since this relationship was only moderate. The prevention of sarcopenia in the hospital environment, with rehabilitation programs focused on strength and endurance training of the peripheral and respiratory muscles, can be seen as important for the prevention or maintenance of strength and muscle mass in the elderly.

Author contributions

Anjos JLM, Luz MRMS and Martinez BP participated in the conception and design of the study. Botelho PM, Rios LF, Maia MS, Luz MRMS, Silva Junior MCM, Jesus SLF, Anjos JLM and Martinez BP participated in the collection and analysis of research data, interpretation of results and writing of the scientific article

Competing interests

No financial, legal or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

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