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ORIGINAL RESEARCH

Assessment of body composition, functional capacity and pulmonary function in patients with Chronic Obstructive Pulmonary Disease

Avaliação da composição corporal, capacidade funcional e função pulmonar em pacientes com Doença Pulmonar Obstrutiva Crônica

Evaluación de la composición corporal, la capacidad funcional y la función pulmonar en pacientes con Enfermedad Pulmonar Obstructiva Crónica

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ABSTRACT | Chronic obstructive pulmonary disease (COPD) is related to a low body mass index (BMI), reduced functional capacity and reduced bone density, thus justifying the importance of evaluating all of these parameters in the patients with the disease. This is a cross-sectional study, with sample consisting of 20 patients who performed measurement of body composition by bioelectrical impedance, evaluation of functional capacity by the distance traveled in the Incremental Shuttle Walk Test (ISWT) and assessment of severity of obstruction by spirometry. Significant differences were found between the travelled and scheduled distance in the ISWT (p<0.01), positive correlations between muscle mass and distance walked in ISWT (r=0.54 with p=0.01), with FEV_1 (r=0.488 with p=0.02), FEV_1 and bone mass (r=0.497 with p=0.02) and distance traveled with FEV_1 (r=0,541 with p=0.01). The correlations found in this study, besides confirming the hypothesis that the severity of the obstruction presented by the change in the lung parenchyma in patients with COPD is related to changes in body composition and functional capacity reduction, also highlight the correlation with bone mass.

Keywords | Body Mass Index; Pulmonary Disease, Chronic Obstructive/physiopathology; Exercise Tolerance.

RESUMO | A doença pulmonar obstrutiva crônica (DPOC) está relacionada a um baixo índice de massa corporal (IMC), à redução da capacidade funcional e à redução da densidade óssea, justificando assim a importância de se avaliar todos esses parâmetros nos pacientes portadores da doença. Trata-se de um estudo transversal, com amostra composta por 20 pacientes, que realizaram medida de composição corporal por bioimpedância, avaliação da capacidade funcional pela distância percorrida no *Incremental Shuttle Walk Test* (ISWT) e avaliação da gravidade da obstrução pela espirometria. Foram encontradas diferenças significantes entre a distância percorrida e prevista do ISWT (p<0,01), correlações positivas entre massa muscular e distância percorrida no ISWT (r=0,54 com p=0,01), com VEF_1 (r=0,488 com p=0,02), VEF_1 e massa óssea (r=0,497 com p=0,02) e distância percorrida com VEF_1 (r=0,541 com p=0,01). As correlações encontradas neste estudo, além de confirmarem a hipótese de que a gravidade da obstrução apresentada pela alteração no parênquima pulmonar nos pacientes com DPOC está relacionada com as alterações na composição corporal e com a redução da capacidade funcional, evidenciam também a correlação com a massa óssea.

Descritores | Índice de Massa Corporal; Doença Pulmonar Obstrutiva Crônica; /fisiopatologia; Tolerância ao Exercício.

Study conducted in the Laboratory of Respiratory Functional Evaluation (LARESP), Universidade Nove de Julho (UNINOVE) – São Paulo (SP), Brazil.
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RESUMEN | La enfermedad pulmonar obstructiva crónica (EPOC) está relacionada con un bajo índice de masa corporal (IMC), reducción de la capacidad funcional y reducción de la densidad ósea, justificando así la importancia de evaluar todos estos parámetros en pacientes con la enfermedad. Este es un estudio transversal, con una muestra de 20 pacientes, que se sometieron a la medición de la composición corporal por bioimpedancia, la evaluación de la capacidad funcional por la distancia recorrida en el *Incremental Shuttle Walk Test* (ISWT) y la evaluación de la gravedad de la obstrucción por la espirometría. Se encontraron diferencias significativas entre la distancia recorrida y prevista del ISWT (p<0,01), correlaciones positivas entre la masa muscular y la distancia en el ISWT (r=0,54 con p=0,01), con FEV_1 (r=0,488 con p=0,02), FEV_1 y la masa ósea (r=0,497 con p=0,02) y la distancia recorrida con el FEV_1 (r=0,541 con p=0,01) . Las correlaciones encontradas en este estudio, además de confirmar la hipótesis de que la gravedad de la obstrucción presentada por los cambios en el parénquima pulmonar en pacientes con EPOC se asocia con cambios en la composición corporal y la reducción de la capacidad funcional, evidencian también la correlación con la masa ósea.

Palabras clave | Índice de Masa Corporal; Enfermedad Obstructiva Crónica/fisiopatología; Tolerancia al Ejercicio.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is a disease that affects primarily the lungs, but it also has significant systemic consequences that lead to the intolerance to physical exercises and activities of daily life. This systemic compromise has been related to survival and general status of patients with the disease[1,2].

Dyspnea generated by changes in lung parenchyma leads patients to chronic sedentary lifestyle. This cycle of dyspnea and sedentary lifestyle promotes peripheral muscular hypotrophy and reduced aerobic capacity, thus resulting in more intense ventilatory demand for dynamic activities and closing the cycle called dyspnea-sedentary lifestyle-dyspnea[3,4].

Common characteristics in patients with COPD, such as low body mass index (BMI), history of smoking, age, inactivity, systemic inflammation and systemic corticorteroids are important risk factors for osteoporosis. The severity of COPD is related to the loss of vertebral bone mineral density[5].

Killian *et al.*[6] first described the importance of this musculoskeletal change in the physical ability of patients with COPD, once patients complained about muscle without necessarily complaining about dyspnea during physical activity.

Different studies[5,7] relate the severity of COPD with low BMI and with bone density, among other factors, associated with the presence of vertebral fractures. However, there are a few studies relating the functional capacity, by means of field tests, with body composition, especially with the use of reliable methods, such as electric bioimpedance. Studies that prove the correlation of these measures are important, once the evaluation of body composition requires specialized devices that are not accessible, while field tests are easy to perform and apply.

Based on that, the objective of this study was to verify if there is a relationship between the different items of body composition, such as functional capacity and the severity of the condition in patients with COPD.

METHODOLOGY

This cross-sectional study was approved by the Ethics Committee of UNINOVE (protocol n. 384767/2011), and the sample was comprised of 20 patients diagnosed with COPD in outpatient follow-up, coming from the pneumology outpatient clinic of *Santa Casa de Misericórdia de São Paulo* (AME) "Dr. Geraldo Bourrol".

Patients from both genders were included, aged more than 40 years old and diagnosed with COPD according to criteria from the Global Initiative for Chronic Obstructive Lung Disease (GOLD). They should be clinically stable, without presenting picture of disease exacerbation in the past 30 days, and they could not be part of any program involving physical activity concomitantly.

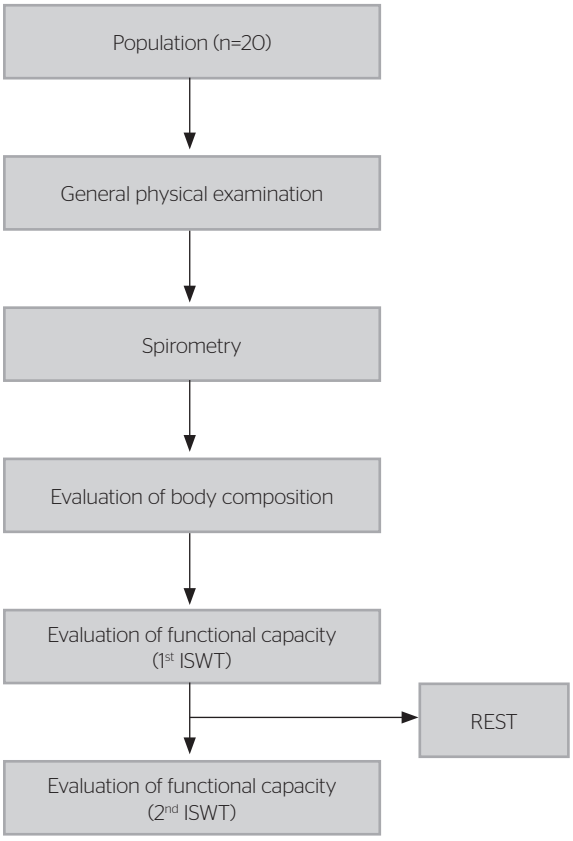
Patients with severe comorbidities, such as previous heart disease, orthopedic conditions in upper and lower limbs, motor or visual sequelae from neurological disease that might interfere with the ability to perform physical exercises, uncontrolled arterial hypertension, associated pulmonary disease and those that did not agree to participate in this study were excluded.

Procedures

Data about past and current history of the disease were collected, and a general physical examination was conducted to ensure the impossibility of exacerbation. Afterwards, the assessment of the severity of obstruction, body composition and functional capacity was conducted according to the following flowchart (Figure 1).

Spirometry

All of the patients were submitted to spirometric evaluation to classify the severity of obstruction, and the following pulmonary volumes, capacities and flows were registered: Slow Vital Capacity (VC), Forced Vital Capacity (FVC) and its derivations, such as Forced Expiratory Volume in one second (FEV_1) and the ratios (FEV_1/FVC and FEV_1/VC). The test consisted of maximal inspiratory and expiratory maneuvers, which were conducted in the device, until it was possible to register three reproducible maneuvers according to the recommendations[8]. All of the tests were conducted in a climatized environment, by means of previously calibrated PFT KoKo® spirometer. The used reference values were in accordance with Pereira *et al.*[9].



ISWT: Incremental Shuttle Walk Test
Figure 1. Experimental procedure

Incremental Shuttle Walk Test

The Incremental Shuttle Walk Test (ISWT), which aims at assessing the functional capacity of the patient, was conducted by a trained evaluator in a 10 meter long corridor with two cones placed 0.5 meter from the end of the route (in order to minimize abrupt direction changes) and with the support of a beeping sound device, that guided the test. The beginning of the test was indicated by a triple beep. Afterwards, this device emitted a single beep in regular intervals, which warned when the subject should leave one extremity of the route to the other, before a new beep was emitted. Each new cycle initiated by a beep presented incremented speed standardized by Singh[10]. The explanation for the patients was standardized and demonstrated before each test. Each patient was advised to walk at a constant pace, aiming to go around the cone and continuing to walk until feeling unable to maintain the necessary speed to reach the other extremity of the route before the next beep, without being extremely out of breath. During the whole test, data concerning heart rate (HR), peripheral oxygen saturation (SpO_2), blood pressure (BP), respiratory frequency (RF), sensation of dyspnea and lower limb fatigue by the Borg scale were monitored. These data were written down every new stage of the test. Oxygen supplementation could be performed in case the patient presented with desaturation below 80%. The test was performed twice, according to the recommendations by Singh[10], with the objective of eliminating possible learning effects. Between each performed test, a 15-minute break was given to the patient in order for him or her to recover, so that his or her vital signs could return to basal levels[10].

Body composition

The body composition of patients was assessed by means of an electrical bioimpedance balance, from Tanita™ BIA (foot to foot). Patients were instructed to respect the following instructions: not to eat or drink 4 hours before the test; not to ingest caffeine or alcohol 12 hours prior to the test; not to perform physical activities 6 hours before the test; and urinate 30 minutes before the test.

The measuring electrode was located on the feet platform, and reading was performed by the direct contact with the skin, which had been previously cleaned with 70% alcohol. The patient was advised to

stand on the scale on orthostatic position for the time established by the device. Body composition calculations were provided automatically by the scale itself, based on the data inserted by the evaluator about height, sex and age of each patient. Comparison data to what was expected for the sex were provided by the manufacturer[11].

Statistical analysis

After submission to the Kolmogorov Smirnov (KS) test, non-parametric data of the predicted value and the obtained one were analyzed by the non-paired t-test and the Wilcoxon test. For the correlation of parametric data, the Pearson correlation was used, and for non-parametric variables, the Spearman correlation was used. Relevant results were those presenting 5% significance level ($p \leq 0.05$). The software Minitab 14 was used.

The sample power was calculated in 90%. By assuming a 0.05 alpha error, based on a study that determines the clinically significant difference for the Incremental Shuttle Walking Test in 78.7 meters, and the standard-deviation being calculated by a 98.59 meter pilot-study, the considered sample number was not lower than 16.

RESULTS

Results were organized in tables, for each variable, by mean and standard-deviation, or interquartile interval according to the nature of the analyzed data.

It is Worth to mention that in the previous evaluation conducted with the patients, no case of clinical picture exacerbation was detected, because they were all stable to be included in the proposed protocol. Anthropometric and spirometric data of the studied sample are presented in Table 1.

During the ISWT, initial and final measures were registered referring to the percentage of HR, SpO_2, as well as the report of dyspnea and lower extremity fatigue, by the Borg scale, and also BP. According to the results of Table 2, none of these variables presented any clinical or statistically significant changes.

The non-paired *t*-test was applied for the predicted and the coursed distance in ISWT, and a significant difference with $p<0.01$ was found.

The results of the test and the results of body composition, obtained by bioimpedance, are also found in Table 2, in mean and standard-deviation of the following variables: fat percentage, water percentage, muscle mass weight and bone mass weight.

The distance coursed in ISWT presented moderate correlation with muscle mass (as presented in Figure 2).

The distance coursed in ISWT also presented similar positive correlation with FEV_1 ($r=0.54$; $p=0.01$),

FEV_1 also presented correlation with thin and bone mass, as illustrated in Figures 3 and 4.

DISCUSSION

According to literature, patients with COPD have reduced physical abilities[1-4], which have been assessed by means of the coursed distance in ISWT, in comparison to predicted values for each individual

Table 1. Mean and standard-deviation of the anthropometric (age, weight, height and body mass index) and spirometric variables (in liters and percentage of the predicted value)

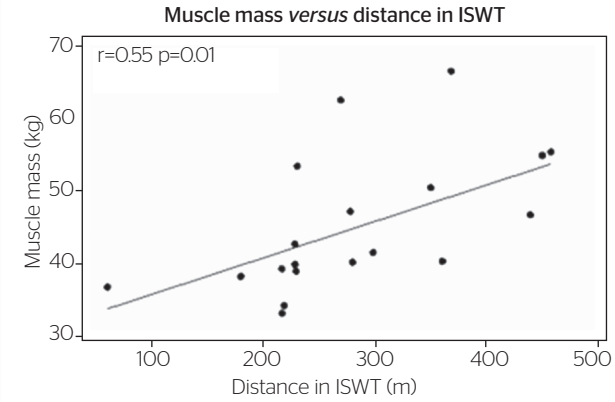
Anthropometric variables	n=20 (7♀) Mean±SD
Age (years)	65.9±5.4
Weight (kg)	63.69±17.9
Height (m)	1.62±0.1
BMI (kg/m²)	24.1±5.8
Spirometric variables	**n=20 (7♀) Mean±SD**
FVC (L)	3.08±0.8
FVC (% predicted)	86.5±22.1
FEV_1 (L)	1.53±0.69
FEV_1 (% predicted)	57.1±20.9
FEV_1/FVC (L)	0.53±0.1
FEV_1/FVC (% predicted)	67.0±16.5

BMI: Body mass index; FVC: Forced Vital Capacity; FEV_1: Forced Expiratory Volume in one second; FEV_1/FVC: Ratio FEV_1/FVC, % predicted: percentage of the predicted value; ♀: women; SD: standard deviation

Table 2. Means and standard-deviation of the Incremental Shuttle Walk Test and body composition

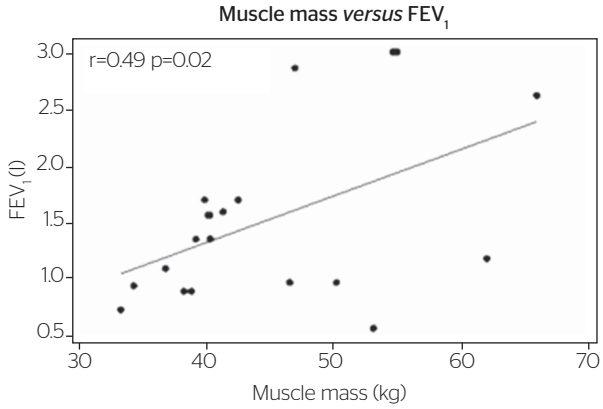
ISWT Variables	n=20 (7♀) Mean±SD
Maximum HR	106±16
% maximum HR	68±10
CD (meters)	205.1±96.7
% predicted CD	62.6±21.5
Body composition	**n=20 (7♀) Mean±SD**
% fat	24.0±10.3
% water	52.3±7.7
Muscle mass weight (kg)	44.7±9.1
Bone mass weight (kg)	2.4±0.45

ISWT: Incremental Shuttle Walk Test; HR: heart rate; %: percentage; CD: coursed distance; ♀: women; SD: standard deviation



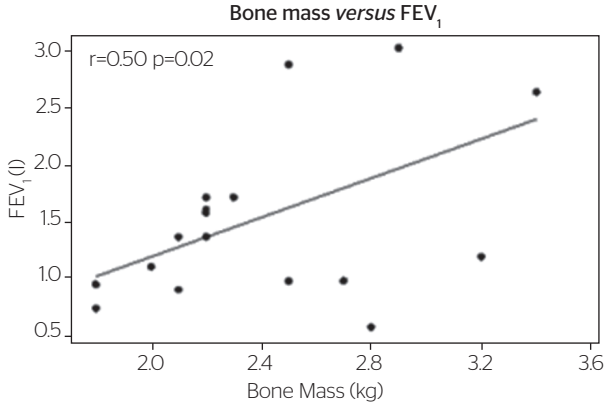
ISWT: Incremental Shuttle Walk Test

Figure 2. Correlation between coursed distance in the Incremental Shuttle Walk Test and muscle mass weight



FEV_1: forced expiratory volume in one second

Figure 3. Correlation between muscle mass and forced expiratory volume in one second



FEV_1: forced expiratory volume in one second

Figura 4. Correlation between forced expiratory volume in one second and bone mass

according to age, weight, height and gender[12]. This is in accordance with our findings, which also revealed significant difference between the coursed distance by the patients with COPD and the predicted distance in ISWT. These physical ability results have been considered to be essentially important to express the functional capacity of patients with COPD, according to literature[7,13,14].

With regard to body composition, even though Pelegrino *et al.*[15] stated that the reduced muscle mass is correlated to worse physical performance in relation to the presented fatigue, not being directly related to the reduced coursed distance in field tests, findings from other studies in literature showed up to 60% variation in the 12-minute walk test[16], and positive significant correlation between muscle mass and the result of the 6-minute walk test[17]. With these findings, with our results we could confirm the correlation between muscle mass and the distance coursed also in ISWT, besides the correlation between pulmonary function and bone mass, which was not explored in that context in literature.

The correlation we found between FEV_1 and the coursed distance in ISWT is in accordance with the deconditioning concept, which is related to this population, since the lack of muscle use, especially peripheral muscles, due to the intense dyspnea presented by these patients during physical activities, leads them to present with muscle atrophy. The more severe the patient (lower FEV_1), the lower the functional capacity due to the lower muscle recruitment during activities of daily life. This finding is in accordance with the review by Nasis *et al.*[7], who also explained the lack of use of peripheral muscles as the cause of reduced muscle mass.

Besides this direct relationship between muscle mass and physical performance, which is well documented, especially among athletes, it is important to consider the possible correlations between the decreased pulmonary function and bone mass changes, especially in this population of patients with COPD, who are also elders. The level of pulmonary obstruction, demonstrated by the decreased FEV_1, is also associated with the risk of osteoporosis, since Kjensli[18] has detected that the number of vertebral deformities is twice as high among women with COPD, GOLD III, in comparison to those who presented with GOLD II. By using the bioimpedance we could observe that the bone mass weight was correlated with the severity of the disease, observed by the decreased FEV_1.

Even though the bone mass evaluation did not earn much attention from patients with COPD, these results are important especially because all of the patients in the sample had been on corticoids for at least ten years. The most severe cases used higher doses, for longer periods of time, and the predisposition to osteoporosis

and fractures are related to the use of corticosteroids, as explored by Vestergaard[19].

It is important to consider some limitations in this study, especially the absence of a Control Group. However, the found results not only confirmed previous findings in literature, but they also called the attention to other aspects besides pulmonary function, as its relationship with the compromised physical performance, particularly with body composition. Therefore, they can subsidize treatment programs, especially of Cardiorespiratory and Musculoskeletal Physical Therapy, therefore, the lower the ability for exercise presented in field tests, the higher the severity of the disease and the higher the risk of fractures and bone deformities. Therefore, the prescription of physical exercise should approach not only deconditioning, but protective and guidance activities. In some situations, a multiprofessional approach, such as the nutritional program for gaining thin mass, is also valid.

CONCLUSION

The correlations found in this study confirm the hypothesis that the severity of the obstruction presented by changes in the lung parenchyma in patients with COPD is related to changes in body composition and to the reduced functional capacity. Particularly, it is important to consider the importance of assessing other aspects besides the pulmonary function of patients with COPD, especially the correlation of pulmonary function and bone mass.

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