Original Article

Muscle strength, functionality and distance traveled in patients with chronic obstructive pulmonary disease

Força muscular, funcionalidade e distância percorrida em pacientes com doença pulmonar obstrutiva crônica

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ABSTRACT | INTRODUCTION: The functional status of individuals with Chronic Obstructive Pulmonary Disease (COPD), considered a predictive indicator of clinical condition and quality of life of this population. **OBJECTIVE:** To analyze muscle strength, morbidity, quality of life and distance traveled in patients with COPD and compare compare them with the group non-COPD. **METHODS:** Fifty-eight volunteers were evaluated, 29 from the COPD group, classified as GOLD II and 29 in the non-COPD group, with the following parameters measured: pulmonary function; anthropometric variables; muscle strength; morbidity through the Body mass index, airway Obstruction, Dyspnea, and Exercise capacity (BODE); quality of life with the Saint George's Respiratory Questionnaire (SGRQ); lung capacity through the distance covered in the six-minute walk test. For statistical analysis, the Shapiro Wilk test and the Mann-Whitney or Student t tests were performed, as well as the Pearson correlation test, for p values < 0,05. **RESULTS:** The mean total age was 61±7 years, the strength of knee extensors (p 0.0004), with lower strength (N) values for the COPD group 110,61±41,69; compared to the non-COPD group 156,31±44,09, the strength of elbow flexors (p 0,004) stands out, with 96,34±26,15 for the COPD group, compared to the non-COPD group 118,19±34,71. In the distance covered in the 6MWT, the COPD group covered an average of 274± 107,86 and the non-COPD group 384,98±100,47 (p<0,05). The BODE presented a correlation between (r = -0,79) and the distance covered in the 6MWT and (r =0,72) with the total Saint George. **CONCLUSIONS:** Patients with COPD presented a reduction in muscle strength of the upper limbs, knee extensors and the distance covered, when compared with the non-COPD group.

KEYWORDS: Chronic obstructive pulmonary disease. Muscle strength. Walk test. Morbidity. Quality of life.

RESUMO | INTRODUÇÃO: O status funcional do indivíduo com Doença Pulmonar Obstrutiva Crônica (DPOC), considerado um indicador preditivo de agravo do quadro clínico e qualidade de vida dessa população. **OBJETIVO:** Analisar a força muscular, morbidade, qualidade de vida e distância percorrida em pacientes com DPOC e comparar com o grupo não DPOC. **MÉTODOS:** Foram avaliados 58 voluntários, 29 do grupo DPOC, classificados em GOLD II e 29 o grupo não DPOC, com os seguintes parâmetros mensurados: função pulmonar; variáveis antropométricas; força muscular; morbidade mediante o índice Body mass index, airway Obstruction, Dyspnea, and Exercise capacity (BODE); qualidade de vida com o questionário do Saint George's Respiratory Questionnaire (SGRQ); capacidade pulmonar através da distância percorrida no teste de caminhada de seis minutos. Para análise estatística, realizado o teste de Shapiro Wilk e os testes de Mann-Whitney ou t de Student, assim como o teste de correlação de Pearson, para valores de p < 0,05. **RESULTADOS:** A idade média total foi de 61±7 anos, a força de extensores de joelho (p:0,0004), com valores de força menores para o grupo DPOC 110,61±41,69; em comparação com do grupo não DPOC 156,31±44,09, destaca-se ainda a força de flexores de cotovelo (p 0,004), com 96,34±26,15 para grupo DPOC, em comparação ao grupo não DPOC 118,19±34,71. Na distância percorrida do TC6M o grupo DPOC percorreu uma média de 274± 107,86 e o grupo não DPOC 384,98±100,47 (p<0,05). O BODE apresentou correlação de (r = -0,79) com a distância percorrida no TC6M e de (r =0,72) com o Saint George total. **CONCLUSÕES:** Os pacientes com DPOC apresentaram redução da força muscular de membros superiores, extensores de joelho e da distância percorrida, ao comparar com o grupo não DPOC.

PALAVRAS-CHAVE: Doença pulmonar obstrutiva crônica. Força muscular. Teste de Caminhada. Morbidade. Qualidade de vida.

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Introduction

Chronic obstructive pulmonary disease COPD, characterized by persistent respiratory symptoms and limitation of the airflow due to changes in the airways and/or alveolar usually caused by significant exposure to harmful particles or gases and parenchymal destruction, whose relative contributions vary according to the individual[1].

In Brazil, about 40 thousand deaths occur each year, and every hour, three Brazilians die as a result of COPD[2]. The epidemiological, clinical and socioeconomic impact of COPD is still constantly increasing, in addition it is expected to be the third leading cause of death in the world by 2030. Considered one of the main causes of morbidity and mortality worldwide, COPD induces a substantial increase and growing economic and social[1].

Chronic inflammation causes narrowing of the small airways and destruction of the lung parenchyma, triggering loss of alveolar accesses in the small airways in which decreases the pulmonary elastic recoil. In turn, these changes decrease the ability of the airways to remain open during expiration. Among the symptoms, the most characteristic of COPD is dyspnea and many factors are involved in its mechanism, including airflow limitation, gas storage, gas exchange abnormalities, mucous hypersecretion, respiratory muscle dysfunction and skeletal muscle dysfunction[1,2]. As the disease progresses, patients suffer from deterioration of functional status and limitations in activities of daily living. Impaired functional status is shown to be predictive of exacerbations, hospitalizations and mortality[3].

With the progression, there is also a reduction in the concentration of type I muscle fibers (slow contraction), consequently the individual loses muscle strength and endurance in the muscle, fatiguing faster[4]. Thus, muscle dysfunction is represented by weakness, reduced resistance and the presence of muscle fatigue, with a 50% prevalence in people with severe or very severe COPD5. The highlight among these characteristics is a substantially reduced level of physical activity[4,5].

Considering the multifactorial cause in muscle weakness, in addition to the decreased functionality that COPD generates during its progression, triggering changes in morbidity, quality of life and even in functional capacity, this study aimed to analyze muscle strength, morbidity, quality of life and distance traveled in COPD patients, and compare them with the control group.

Methods

This is a cross-sectional study, from February to May 2018, which included 58 patients of both sexes, aged between 49 and 77 years. These were divided into 2 groups: The first composed of individuals with a clinical diagnosis of COPD with moderate airflow obstruction (GOLD II), established by the standards of the Global Initiative for Chronic Obstructive Lung Disease. (GOLD)[1]; Non-COPD and non-smoking group, without pulmonary lesions, after clinical evaluation by the pulmonologist, thus composing the control group.

The inclusion criteria were an outpatient of the pulmonology service of the University Hospital of the Federal University of Sergipe, Aracaju-SE, Brazil; having a clinical diagnosis of COPD for at least 6 months; appear with a spirometry exam in the medical record, carried out at least 3 months prior; having clinical stability, be 40 years old or older; not having infections and exacerbations in the last 3 months and no musculoskeletal changes that limited gait. Those who suffered a fracture, injury or trauma that could interfere with the assessment of muscle strength were excluded, as well as those who have undergone abdominal and thoracic surgery recently.

The survey has been approved under CAAE: 80590617.3.0000.5546, of the Research Ethics Committee of the Federal University of Sergipe, opinion Number. 2.434,.504. All patients were informed about the procedures and signed a Free and Informed Consent Form (ICF) before participating in the study.

Among the variables studied, the body mass index (BMI) was calculated using the equation weight(kg) / height²(m). Pulmonary functional capacity was assessed using spirometry, using a spirometer (Minispir), and it is possible to observe the forced expiratory volume in the first second (VEF1) and the FEV1 / Forced Vital Capacity (FVC) ratio, measured at the pulmonology clinic.

Subsequently, they underwent muscle strength assessment: biceps brachial, triceps, wrist flexors and quadriceps, performed on the dominant limb informed by the patient and quantified using the MicroFET® 2 portable dynamometer (Hoggan Health Industries, West Jordan, UT, USA), high threshold mode. The unit of the force variable obtained was in Newton (N). The patient was positioned seated in a chair with armrests, maintaining a 90° angle of hips and knees, with the hands resting on the chair. With the dynamometer positioned on the distal portion of the limb, the patient performed the movement resisting the evaluator's force in the last degrees of movement and holding for 3 seconds. 3 movements were performed on the dominant limb, with a rest time of 30 seconds between each of them6. The highest value was considered the peak force (PF).

The strength test was performed by the same evaluator, with standardized and vigorous verbal encouragement during the maneuver, with the aim of encouraging the patient to perform a maximum effort during the entire period of muscle contraction and the evaluator was attentive to the compensations and valsalva maneuver.

Subsequently, morbidity was assessed using the Body Mass-Index, Airflow Obstruction, Dyspnea and Exercise Capacity (BODE). The BODE index of each individual was calculated based on the combination of four variables, with the following scores: a measure of body composition, the BMI, from 0 to 1 point; a measure of the intensity of airflow obstruction (VEF1% predicted pre-bronchodilator), from 0 to 3 points; a measure of the subjective sensation of dyspnea (MRC scale), from 0 to 3 points and a measure of the exercise capacity (distance traveled in the 6MWT), from 0 to 3 points. The final score of the BODE index ranges from 0 to 10 points, and the higher the value of the index, the worse the patient's condition[8].

The subjective assessment of the sensation of dyspnea was performed using the MRC scale, to compose the BODE index. Validated in Portuguese and composed of only five items, among which the patient chooses the item that corresponds to how much the dyspnea limits his daily life[7,8].

The Saint George Hospital Respiratory Disease Questionnaire (SGRQ) was applied to assess health-related quality of life[9,10]. This instrument is specific for chronic respiratory diseases, consisting of 76 items and divided into three domains: 1) Symptoms: related to complaints of respiratory problems, (maximum score: 662,5); 2) Activities: related to activities that have normally caused shortness of breath in the past few days, (maximum score: 1209,1); and 3) Impact: related to disease control and interference with functional activities, (maximum score: 2117,8). The total is the sum of all questions and sections of the questionnaire and its maximum score is 3989,4.

For physical capacity, the 6-minute walk test (6MWT) was performed according to the guidelines established by the American Thoracic Society[11]. Executed on a 30-meter terrain, flat and without obstacles, by the same experienced appraiser. Vital data such as systemic blood pressure, heart rate, respiratory rate, dyspnea level (Borg scale) and oxygen saturation were measured before and after the test. The patient was asked to walk from one end of the track to the other, with the highest possible speed, during the six minutes under monitoring by the evaluator.

If the patient felt symptoms such as pain in the lower limbs, tachycardia or any other symptom of discomfort, the test was stopped immediately. The sequence of tests performed was established in order to reduce the volunteer's physical fatigue. Starting with the strength assessment, a 5-minute rest, followed by the 6MWT. To calculate the predicted distance in the 6MWT, the formula was used: 890,46 – (6,11 x age) + (0,0345 x age²) + (48,87 x gender) – (4,81 x BMI) [male = 1, female = 0]; proposed by Brito et al.[12].

Statistical analysis

Data were presented using means and standard deviations (± SD). The distributions of the numerical variables were initially analyzed using the Shapiro-Wilk normality test, after this analysis, the data were compared between the COPD group and the control group using the Student t or Mann-Whitney test, according to the normality. Pearson's coefficient (r) 7 was used for the correlations, classifying as: Null (0), weak (0 to 0,3), regular (0,3 to 0,6), strong (0,6 to 0, 9) or very strong (0,9 to 1). The software used for statistical analysis was Bioestat 5.3 and was considered a significance level of 95% (p <0,05).

Results

In the sample of 58 individuals, 29 non-COPD individuals and 29 with a diagnosis of COPD classified as moderate GOLD II airflow obstruction and described demographically in Table 1. The mean age was 61,46 ± 8,94 years and body mass index (BMI) with a mean of 25,87±4,84kg/m². Predictably, the healthy group was more active in terms of level of physical activity and functional capacity assessed by the 6MWT.

The COPD group obtained a lower distance in the 6MWT (274,51 ± 107,86) not only to its predicted (405,03 (p = 0,05)), but also to the Control Group (384,98 ± 100,47). Thus, it shows a better physical performance of the individuals in the Control Group (p = 0,001).

Table 1. Demographic and clinical characterization of the moderate COPD sample and the non-COPD group from February to May 2018

	COPD (n=29)	No COPD (n=29)	p
Age	64,24 ± 8,33	58,68 ± 8,79	0,04
BMI (kg/m²)	24,17 ± 4,81	27,58 ± 4,30	0,004
Gender (m/f)	12/17	6/23	-
Sedentary % (n)	89,66 (26)	41,38 (12)	-
Smoking % (n)	37,93 (11)	0 (0)	-
Alcoholism% (n)	6,89 (2)	13,79 (4)	-
Exposure of toxic gases % (n)	68,96 (20)	10,34 (3)	-
(6MWT)	274,51 ± 107,86	384,98 ± 100,47	0,001
FEV1 (Pre bronchodilator(L))	1,11 ± 0,25	-	-

m: male; f: female; BMI: body mass index; 6MWT: six-minute walk test; FEV1(L): forced expiratory volume in the first minute, in Liters. Data presented in absolute frequency, mean ± SD and student t test was used to compare the variables.

Table 2. Comparison of COPD muscle strength and the non-COPD group from February to May 2018

Muscle group	COPD	Group non-COPD	p
Elbow Flexors (N)	96,34 ± 26,15	118,19 ± 34,71	0,004*
Elbow Extenders (N)	74,14 ± 23,86	94,09 ± 33,05	0,01*
Wrist Flexors (N)	72,53 ± 19,79	88,47 ± 21,41	0,003*
Knee Extenders (N)	110,61 ± 41,69	156,31 ± 44,09	0,0004*

*: Values < 0.05. N: Muscle strength in Newton; Student's t-test for comparison of variables.

There was a statistical difference, table 2, between the COPD group and the Non-COPD group, in relation to muscle strength in all muscle groups, especially knee extensors (p 0,0004). COPD group were evaluated for quality of life and the mean value of 1793,43±832,35, was found for the morbidity index the value of 4,79±2,65 (Table 3).

Table 3. Presentation of mean and standard deviation of the Saint George Questionnaire and BODE Index, in COPD and the non-COPD group from February to May 2018

	COPD Group	Maximum reference value
Symptoms	298,07 ±173,23	662,5
Activity	644,77±331,49	1209,1
Impact	849,38±422,03	2117,8
Saint George total	1793,43±832,35	3989,4
BODE Index	4,79±2,65	10,0

A correlation was found between the BODE index and showed a strong positive correlation with the activity domain of Saint George (r = 0,73), with total Saint George (r = 0,72); strong negative correlation with forced expiratory volume in the first second (FEV1) (r = -0,82); 6MWT (r = -0,79). Saint George presented a moderate negative correlation with FEV1 (r = - 0,57) and with the 6MWT (r = -0,56) (table 4).

Table 4. Correlation between primary variables in COPD and the non-COPD group from February to May 2018

VARIABLES	r*
VEF1 X BODE	- 0,82
6MWT X BODE	-0,79
Elbow Flexors X BODE	-0,24
Elbow Extenders X BODE	-0,20
Wrist Flexors X BODE	-0,51
Knee Extenders X BODE	-0,27
Symptoms X BODE	0,50
Activity X BODE	0,73
Impact X BODE	0,65
Saint George(total) X BODE	0,72
Saint George(total) X 6MWT	-0,56
Saint George(total) X VEF1	-0,57

*r= correlation value between variables; Pearson coefficient for correlation of variables.

Discussão

This study found loss of muscle strength and decline in functional capacity in COPD patients, GOLD II. Studies show that sedentary lifestyle is an important modifiable risk factor, being present in 78,3% of patients[13,14], according to this study, in which the percentage of sedentary lifestyle found in patients with COPD was 89,66%, so the group with COPD was predominantly sedentary, only 10% of it performs some type of regular physical activity. While 58% of non-COPD volunteers reported regular physical activity, it is suggested that due to factors such as the presence of dyspnea, COPD patient reduces the practice of physical activity causing consequences such as muscle weakness of both lower limbs and upper limbs.

The sociodemographic characteristics of patients with COPD II in the present study were similar to other studies[6], corroborating, with the frequency of COPD-GOLD II among individuals over 65 years of age and with a history of significant smoking, the plausible justification in the present study was because it was a convenience sample.

Authors show that the systemic inflammatory process, together with oxidative stress in COPD, triggers several changes in bioenergetics and skeletal muscles structural, its outcome, corroborates with our results that shows the reduction of the strength of the muscles of the upper limbs when compared to the non-COPD group, and consequently generates a low exercise capacity and lower muscle performance in patients with COPD[6].

Another study[15] evaluated the quadriceps strength in 75 patients in stage IV of COPD (GOLD classification), in which 92% of the participants had decreased quadriceps muscle strength and 76,5% of them classified with mild to moderate airflow obstruction, unlike this study, because it is performed only in COPD in stage II. However, the results showed that both groups presented good muscle strength considering the predicted mean value of 101.56 for the COPD group and 93.86 for the non-COPD group.

These results indicate a functional decline, implying a history of weight loss, which usually represents loss of muscle mass[15], it is observed in this population that the loss of muscle strength observed in the early stages of the disease precedes the onset of symptoms that induce reduced conditioning in daily activities[15,16]. Peripheral muscle weakness is due to disuse atrophy, caused by physical deconditioning predominantly found in THE IM[15,17], in which it favors functional impacts mainly on activities of daily living (ADl's), and greater limitation in developing them. In addition, other symptoms such as reduced lung capacity, dyspnea, dynamic hyperinflation and psychic factors related to fear of fatigue make the individual predisposed to muscle weakness[18].

As for the muscle strength of the upper limbs, it is known that distal muscle strength of the wrist can be preserved, taking into account that patients with COPD are able to continue performing activities of daily living that involve repeated movements of the wrist, including grasping, holding and carrying objects[19], therefore, it is important for the development of activities of daily living, since it is a musculature that is being recruited in most activities.

BMI presents a relationship of dependence with muscle strength, in which the low body mass index is more likely to evolve to muscle weakness[18,20]. The statement may explain the result of the research in presenting mean peak quadriceps strength higher than the predicted value. Regarding the muscle strength of the upper limb, the control group presented a higher mean peak strength than the COPD group, because the mean BMI of the COPD sample was 24,17kg/m^2, while the mean BMI of the control group was 27,58kg/m^2.

Regarding the 6MWT, the results of the study confirmed that patients with COPD travel a shorter distance compared to healthy patients. Among the possible reasons, sedentary lifestyle is suggested because it has a strong characteristic in this group, corroborating the study by Hernandes et al.[21], when observing that individuals who have the disease spend most of their time sitting or lying down, as a way to avoid the symptom of dyspnea, in addition to walking with less intensity of movement. The authors suggest that the fact can be attributed to the lifestyle adopted by him as a consequence of the disease. The opposite is also stated by other authors[20,21], in which inactivity may be a precursor to systemic changes and not a consequence of the severity of the disease.

However, studies[21] propose that the 6MWT is more suitable for functional capacity when compared to FEV1. In our study, the COPD group was more inactive and consequently traveled a shorter distance in the 6MWT. When comparing the distance traveled in the 6MWT obtained with the predicted, a low distance was observed throughout the sample, resulting in a significant reduction in physical capacity, with a deficit of 29%, in agreement with other studies[21,22], which indicate that the reduction of tolerance to physical exercise is a significant indicator of mortality and worse quality of life in obstructive pulmonary disease.

Regarding age, studies[21,22] confirm that the older the age, the shorter the distance traveled. Regarding BMI[27], it was observed that elderly with index < 25 Kg.m^2 walked longer in meters than volunteers with index > 25 Kg/m^2. In contrast to the results of this research, in which the sample obtained an average BMI = 25 Kg/m2, the two groups had low results in the 6MWT when compared to the predicted.

Regarding the BODE index and its functional correlations, the variable that best correlated was FEV1 (r = -0,82). The BODE showed a strong correlation with the total SGRQ score (r =0,72) and also with the activity domain of the SGRQ score (r= 0,73), but presented a moderate correlation (r = 0,50) with the symptom domain, corroborating other studies23,24. Quality of life is impaired in patients with COPD and deteriorates with increased severity of the disease, which is associated with a significant increase in the SGRQ score.

In addition, studies[23,24,25], show that a higher smoking rate affects the quality of life of individuals with COPD, especially with patients' symptoms and the impact score, which describes the psychological status of patients. Another study showed that the Activities domain that measures the difficulty in performing daily physical activities, demonstrating how respiratory functional limitation is negatively associated with performing these daily tasks and consequently in the quality of life of these patients resulted in the highest mean percentage score of 80,4 ± 7,2[25].

As limiting factors of our study, the sample was selected for convenience, not being representative of the total population; the number of patients distributed by gender was not similar between the groups. A (n) small stand out compared to other studies, due to the refusal of some patients to be part of the research.

Conclusion

The patients with COPD evaluated presented reduced muscle strength of elbow flexors and extensors, wrist flexors, knee extensors and shorter distance traveled when compared to the non-COPD group.

Author contributions

Silva DM participated in the design and planning, data collection, critical review of the content and approval of the final version of the manuscript. Santos DN, Souza GPO and Cruz VSF participated in data collection, preparation of the first version, critical review of the content and approval of the final version. Gomes LX participated in the conception and planning, collection, analysis and interpretation of data, preparation of the first version, critical review of the content and approval of the final version of the manuscript. Matos CJO participated in the conception and planning, analysis and interpretation of data, preparation of the first version, critical review of the content and approval of the final version.

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.).

References

1. Gold 20120. Glob Inititiative Chronic Obstr Lung Dis. [Internet]. 2020. Available from: https://goldcopd.org/

2. Brasil. Ministério da Saúde. Portaria SAS/MS no 609, de 06 de junho de 2013, retificada em 14 de junho de 2013. Protocolo Clínico e Diretrizes Terapêuticas: Doença pulmonar obstrutiva crônica. [cited 2020 Jan 30]; Available from: https://portalarquivos2.saude.gov.br/images/pdf/2014/abril/02/pcdt-doenca-pulmonar-obs-cronica-livro-2013.pdf

3. Liu Y, Li H, Ding N, Wang N, Wen D. Functional Status Assessment of Patients With COPD. Medicine (Baltimore). 2016;95(20):e3672. doi: 10.1097/MD.0000000000003672

4. Silva ALG, Garmatz E, Carvalho LL, Cardoso DM, Paiva DN. Handgrip and functional capacity in Chronic Obstructive Pulmonary Disease patients. Fisioter Mov. 2017;30(3):501-7. doi: 10.1590/1980-5918.030.003.ao08

5. Santos K, Karloh M, Gulart AA, Munari AB, Mayer AF. Relação entre força muscular periférica e respiratória e qualidade de vida em pacientes com doença pulmonar obstrutiva crônica. Med (Ribeirão Preto). 2015;48(5):417-24. doi: 10.11606/issn.2176-7262.v48i5p417-424

6. Nyberg A, Saey D, Maltais F. Why and how limb muscle mass and function should be measured in patients with chronic obstructive pulmonary disease. Ann Am Thorac Soc. 2015;12(9):1269-77. doi: 10.1513/AnnalsATS.201505-278PS

7. Pearson K, Fisher RA, Henry FI. Karl Pearson and R. A. Fisher on Statistical Tests: A 1935 Exchange from Nature. The American Statistician. 1994;48(1):2-11. doi: 10.2307/2685077

8. Celli BR, Cote CG, Marin JM, Casanova C, Oca MM, Mendez RA et al. The Body-Mass Index, Airflow Obstruction, Dyspnea, and Exercise Capacity Index in Chronic Obstructive Pulmonary Disease. N Engl J Med. 2004;350(10):1005-12. doi: 10.1056/NEJMoa021322

9. Jones PW, Quirk FH, Baveystock CM. The St George's Respiratory Questionnaire. Respir Med. 1991;(Suppl):25-31. doi: 10.1016/s0954-6111(06)80166-6

10. Sousa TC, Jardim JR, Jones P. Validação do Questionário do Hospital Saint George na Doença Respiratória (SGRQ) em pacientes portadores de doença pulmonar obstrutiva crônica no Brasil. J Pneumol. 2000;26(3):119-28. doi: 10.1590/S0102-35862000000300004

11. Crapo RO, Casaburi R, Coates AL, Enright PL, MacIntyre NR, McKay RT et al. ATS statement: Guidelines for the six-minute walk test. Am J Respir Crit Care Med. 2002;166(1):111-7. doi: 10.1164/ajrccm.166.1.at1102

12. Britto RR, Probst VS, Andrande AF, Samora GA, Hernandes NA, Marinho PE et al. Reference equations for six-minute walk distance based on a Brasilian multicenter study. Braz J Phys Ther. 2013;17(6):556-63. doi: 10.1590/S1413-35552012005000122

13. Giacomelli IL, Steidle LJM, Moreira FF, Meyer IV, Souza RG, Pincelli MP. Pacientes portadores de DPOC hospitalizados: análise do tratamento prévio. J Bras Pneumol Brasília. 2014;40(3):229-37. doi: 10.1590/S1806-37132014000300005

14. Landal AC, Monteiro F, Hevely BCS, Kanesawa LM, Hernandes N, Pitta F. Fatores associados à melhora da composição corporal em indivíduos com DPOC após treinamento físico. Fisioter em Mov. 2014;27(4):633-41. doi: 10.1590/0103-5150.027.004.AO15

15. Kharbanda S, Ramakrishna A, Krishnan S. Prevalence of quadriceps muscle weakness in patients with COPD and its association with disease severity. Int J Chron Obs Pulmon Dis. 2015;10:1727-35. doi: 10.2147/COPD.S87791

16. Bone AE, Hepgul N, Kon S, Maddocks M. Sarcopenia and frailty in chronic respiratory disease: Lessons from gerontology. Chron Respir Dis. 2017;14(1):85-99. doi: 10.1177/1479972316679664

17. Shrikrishna D, Patel M, Tanner RJ, Seymour JM, Connolly BA, Puthucheary ZA et al. Quadriceps wasting and physical inactivity in patients with COPD. Eur Respir J. 2012;40(5):1115-22. doi: 10.1183/09031936.00170111

18. Man WD-C, Soliman MG, Nikoletou D, Harris ML, Rafferty GF, Mustfa N et al. Non-volitional assessment of skeletal muscle strength in patients with chronic obstructive pulmonary disease. Thorax. 2003;58(8):665-9. doi: 10.1136/thorax.58.8.665

19. Polkey MI, Rabe KF. Chicken or egg: Physical activity in COPD revisited. Eur Respir J. 2009;33(2):227-9. doi: 10.1183/09031936.00176808

20. Aquino ES, Peres TM, Lopes IBV, Cantro FMR, Coelho CC, Cunha Filho IT. Correlação entre a composição corporal e força, resistência Da Musculatura respiratória e capacidade de Exercício em pacientes com doença pulmonar obstrutiva crônica. Fisioter e Pesqui. 2010;17(1):58-62. doi: 10.1590/S1809-29502010000100011

21. Hernandes NA, Teixeira DC, Probst VS, Brunetto AF, Ramos EM, Pitta F. Profile of the level of physical activity in the daily lives of patients with COPD in Brazil. J Bras Pneumol. 2009;35(10):949-56. doi: 10.1590/s1806-37132009001000002

22. Garcia-Rio F, Rojo B, Casitas R, Lores V, Madero R, Romero D et al. Prognostic value of the objective measurement of daily physical activity in patients with COPD. Chest. 2012;142(2):338-46. doi: 10.1378/chest.11-2014

23. Hill K, Gardiner P, Cavalheri V, Jenkins S, Healy G. Physical activity and sedentary behaviour: applying lessons to chronic obstructive pulmonary disease. Intern Med J. 2015;45(5):474-82. doi: 10.1111/imj.12570

24. Sarka SK, Das SK, Choudhury S, Datta S, Sarkar S, Basuthakur S et al. Evaluation of correlation of BODE index with health-related quality of life among patients with stable COPD attending a tertiary care hospital. Lung India. 2015;32(1):24-8. doi: 10.4103/0970-2113.148434

25. Pôncio TGHO, Carvalho DS, Randow RM. Avaliação da qualidade de vida de pacientes em oxigenoterapia domiciliar em um município da zona da mata mineira. II Jornada de Iniciação Científica da FACIG. 2017; Minas Gerais: Centro Universitário UNIFACIG;2017. P. 1-5.