



Physiological response to the Glittre-ADL test in elderly COPD patients

Resposta fisiológica ao teste AVD-Glittre em idosos com DPOC

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Abstract

Introduction: The Glittre-ADL (TGlittre) test was developed to assess functional capacity in a group of activities of daily living, but little is known about the physiological responses expected during its implementation. **Objective:** To evaluate the physiological responses induced by TGlittre in COPD patients and compare them with those induced by the 6-minute walk test (6MWT). **Method:** This is a cross-sectional study involving 15 elderly patients with COPD (70±6 years and predicted FEV₁ of 47±16%). The TGlittre and 6MWT were performed on two different days, evaluating heart rate, peripheral oxygen saturation and perceived exertion in the 1st, 4th and 6th minutes of the 6MWT and at the start, after each lap and the end of TGlittre. After the normality test (Shapiro-Wilk), the Wilcoxon test was applied to compare the functional tests, and Spearman's correlation coefficient to assess the association between variables. **Results:** At the end of TGlittre, heart rate was faster than in the 6MWT (106.7±21.9 vs 96.4±16.2bpm, p = 0.02). The other physiological variables were similar at the end of both tests. Heart rate at the end of TGlittre correlated with the final heart rate in the 6MWT (r = 0.69; p = 0.002). **Conclusion:** TGlittre induced a faster heart rate than in the 6MWT, with increased metabolic demand, but with similar ventilatory responses.

Keywords: Heart Rate. Energy Metabolism. Exercise Tolerance. Aged. Chronic Obstructive Pulmonary Disease.

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Resumo

Introdução: O Teste AVD-Glittre (TGlittre) foi desenvolvido para avaliar a capacidade funcional por meio de um grupo de atividades de vida diária, porém ainda pouco se sabe sobre as respostas fisiológicas esperadas durante a sua execução. **Objetivo:** Avaliar as respostas fisiológicas induzidas pelo TGlittre em pacientes idosos com DPOC em comparação as respostas induzidas pelo Teste de Caminhada de 6 Minutos (TC6m). **Método:** Estudo observacional transversal. Participaram 15 pacientes idosos com DPOC (70 ± 6 anos, VEF_1 : $47 \pm 16\%$ do previsto). Em dois dias diferentes, realizou-se o TGlittre e o TC6m, registrando-se a frequência cardíaca, saturação periférica de oxigênio e a percepção de esforço no 1º, 4º e 6º minutos do TC6m e no início, após cada volta e ao final do TGlittre. Após a análise de normalidade (Shapiro-Wilk), utilizou-se o teste de Wilcoxon para comparações entre as variáveis fisiológicas em resposta aos testes funcionais e o coeficiente de correlação de Spearman para verificar a associação entre as variáveis. **Resultados:** Ao final do TGlittre, a frequência cardíaca foi superior à do TC6m ($106,7 \pm 21,9$ vs $96,4 \pm 16,2$ bpm, $p = 0,02$). As demais variáveis fisiológicas foram similares ao final em ambos os testes. A frequência cardíaca final do TGlittre correlacionou-se com a frequência cardíaca final do TC6m ($r = 0,69$; $p = 0,002$). **Conclusão:** O TGlittre foi capaz de induzir a uma frequência cardíaca superior em relação ao TC6m, com maior demanda metabólica, porém com respostas ventilatórias similares no grupo estudado.

Palavras-chave: Frequência Cardíaca. Metabolismo Energético. Tolerância ao Exercício. Idoso. Doença Pulmonar Obstrutiva Crônica.

Introduction

Chronic obstructive pulmonary disease (COPD) is one of the main causes of morbidity and mortality worldwide, and the fourth cause of death [1, 2]. In Brazil, the estimated prevalence rate is 15.8%, with under-diagnosis of around 70% for new cases [2, 3]. The disease is characterized by respiratory systems and chronic limitation in air flow due to changes in airways and/or alveoli caused by significant exposure to particles or harmful gases [1]. This airflow limitation hinders expiration, resulting in pulmonary hyperinflation due to air trapping, especially during exercise, compromising physical activity at the same intensity or duration as healthy individuals of the same age [1, 4, 5].

In addition, individuals with COPD exhibit compromised oxygen transport mechanisms, leading to a decline in cardiovascular function, which may reduce the systemic release of oxygen to the skeletal muscles, resulting in exercise intolerance [6]. Thus, there is an imbalance between the ability to exercise and the metabolic demand with increasing workload during exercise, which provokes an intense feeling of dyspnea, reduced aerobic capacity and early anaerobic threshold, culminating in systemic overload and interrupted exercise [4 - 7].

Different tests are available in the literature to assess functional capacity in individuals with COPD, the six-minute walk test (6MWT) being the most well-known and widely used [1, 5, 8]. The 6MWT, a submaximal test of functional capacity, is strongly correlated to peak oxygen consumption and maximum work capacity [9]. The Glittre-ADL (TGlittre) test, developed to measure functional capacity using a standardized series of activities of daily living (ADL), is strongly correlated to forced expiratory volume in the first second (FEV1), the activity component of the St. George Respiratory Questionnaire (SGRQ), dyspnea during ADL, exercise capacity and hospitalization rate [10]. Both reflect the limited functional capacity of individuals with COPD; however, the TGlittre encompasses more ADL-related activities than the 6MWT [8, 11].

Given that the TGlittre is a more comprehensive assessment of functionality compared to the 6MWT and the need to better understand the responses to this test, the present study aimed at evaluating TGlittre-induced physiological responses in elderly patients with COPD when compared to the 6MWT.

Method

Study design

This is a cross-sectional study, comparing the physiological responses to two functional capacity tests in elderly with COPD undergoing pulmonary rehabilitation. It was conducted between December 2015 and March 2016, after approval from the Human Research Ethics Committee of João de Barros University Hospital under protocol number 1.338.261/2015, and all the participants provided written informed consent. This study complied with the recommendations of Strengthening the Reporting of Observational Studies in Epidemiology [12].

Sample

The following inclusion criteria were established: age ≥ 60 years, both sexes, diagnosed with COPD (forced expiratory volume in the first second/forced vital capacity ratio < 0.70) [1], not dependent on oxygen, clinically stable (no disease exacerbation, characterized by an increase and/or change in respiratory secretion aspect, cough, fatigue and increase in dyspnea), under drug treatment and enrolled in the pulmonary rehabilitation program for at least six months. The pulmonary rehabilitation program consisted of aerobic, strength and relaxation exercises, conducted twice a week for 50 minutes per session.

Procedure

Assessments were carried out at João de Barros Barreto University Hospital over three days. On the first day, participants were submitted to anamnesis to collect the following information: age, sex, weight, height, body mass index, history of smoking and pulmonary function data obtained from the patients' medical chart. The 6MWT and TGlittre tests were conducted on the second and third days, respectively.

Instruments

The 6MWT was carried out according to European Respiratory Society/American Thoracic Society recommendations [13]. Patients were instructed to walk as far as possible, without running, on a 30m-long straight flat corridor, encouraged by standard phrases every minute.

Peripheral oxygen saturation (SpO_2), heart rate (HR) and perceived exertion (Borg Rating of Perceived Exertion Scale) (0-10) [14] were monitored in the 1st, 4th and 6th minute of the test. The total distance travelled was recorded and the better of the two tests was analyzed.

In TGlittre, patients were initially seated, carrying a backpack (2.5 kg for women and 5kg for men) [10]. Next, the subjects walked along a 10m corridor, with a ladder placed halfway along the course, arriving at a shelf where they had to move 3 weights (1 kg each) from the top shelf (at the height of the scapular waist) to the bottom shelf (at the height of the pelvis) and then, to the floor. They then replaced the weights in reverse order and returned to the initial sitting position. The test ended when five cycles were completed. Patients were instructed to perform the test as fast as possible. Total time spent on the test was recorded. SpO_2 , HR and the Borg rating of perceived exertion (0-10) [14] were measured at the start, after each lap and at the end of the test.

Statistical analysis

The GraphPad Prism 6 program (GraphPad Software, Inc, San Diego, CA) was used for the analyses. The Shapiro-Wilk test was applied to assess data distribution. Parametric data are presented as mean and standard deviation and nonparametric data as median and 25-75% interquartile range. The Wilcoxon test was used for comparisons between the physiological variables induced by the functional tests and Spearman's correlation to analyze the correlation between variables. In order to determine the magnitude of correlations, the following classification was adopted: < 0.4 (weak), > 0.4 to < 0.5 (moderate) and > 0.5 (strong) [15]. Significance was set at $p = 0.05$.

Results

Fifteen patients (12 men and three women) were included (Figure 1). The elderly had been enrolled in the pulmonary rehabilitation program for 15 ± 8 months (mean \pm standard deviation). Anthropometric characteristics, pulmonary function, distance walked in the 6MWT and time taken to complete the TGlittre are presented in Table 1.

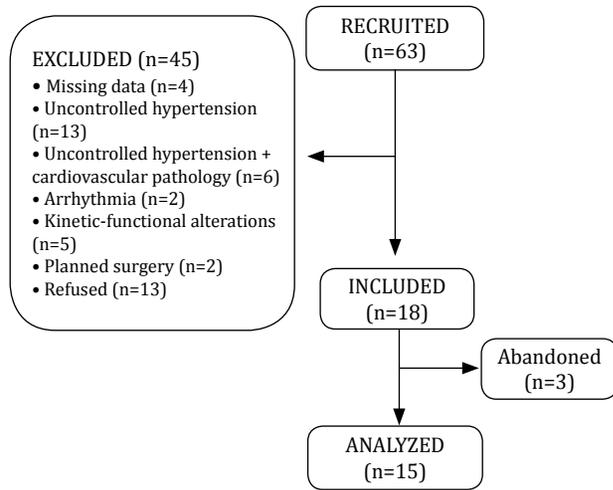


Figure 1 - Sample selection procedure.

Source: The authors.

Table 1 - Anthropometric characteristics, pulmonary function, distance walked in the 6MWT and time spent on the TGlittre

Variable (unit)	
Age (years)	70±6
Weight (kg)	63 (52–68)
Height (m)	1.6 (1.6–1.7)
BMI (kg/m ²)	24 (22–26)
GOLD classification	
Mild	1 (7)
Moderate	5 (33)
Severe	7 (47)
Very severe	2 (13)
FEV ₁ (% predicted)	47±16
FVC (% predicted)	62±18
FEV ₁ /FVC (%)	53±9
Distance in the 6MWT (m)	423 (346–479)
Time in the TGlittre (min)	6 (5–8)

Note: BMI = body mass index; GOLD = Global Initiative for Chronic Obstructive Pulmonary Disease; FEV1 = forced expiratory volume in the first second; FVC = forced vital capacity; 6MWT = 6-minute walk test; TGlittre = Glittre-ADL test. Results presented as mean ± standard deviation or median (25-75% interquartile) or n (%).

With respect to the physiological variables in the two tests, the following means were observed at the end of the 6MWT: HR (96.4±16.2 bpm); SpO₂ (94.3±3.2%); and Borg (3.9±2.0), and the end of the TGlittre: HR (106.7±21.9 bpm); SpO₂ (91.9±5.8%); and Borg (4.3±1.2). Only the final HR of TGlittre

was significantly higher than that of the 6MWT (p = 0.02). There was a significant positive correlation between the final HR of the 6MWT and the TGlittre (r = 0.69; p = 0.002) (Figure 2).

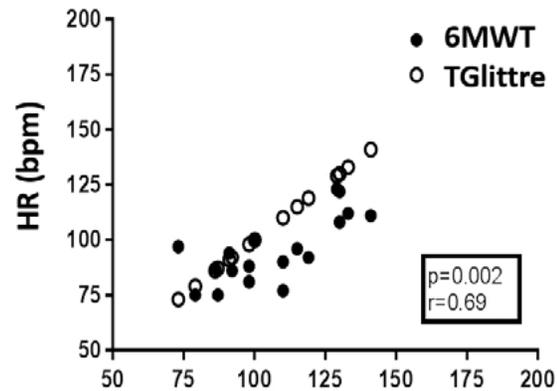


Figure 2 - Correlation between final heart rate of the 6MWT and TGlittre.

Discussion

The present study demonstrated that the physiological responses of elderly with COPD submitted to two different functional capacity tests are similar, except final HR. Both tests promoted an increase in final HR, with a strong positive correlation between them and the TGlittre seemingly imposing a larger load.

With respect to the 6MWT, the distance walked in the present study was around 423 (346–479) m, similar to the findings of Rausch-Osthoff et al. [16] and Mazzocchi et al. [17], who observed comparable behavior in individuals with COPD (approximately 400 m walked in the 6MWT), confirming reproducibility of the test in the group under study.

The elderly took about 6 (5-8) min to complete the TGlittre, demonstrating altered functional capacity, as proposed by Gulart et al. [18], who established a cutoff point of 3.5 min in the TGlittre to discriminate individuals with COPD with normal and abnormal functional capacity. These findings are also confirmed by Corrêa et al. [19], where individuals with COPD performed worse in the TGlittre than healthy seniors (5.3±2.9 min vs. 3.3±0.3 min). According to Skumlien et al. [10] and Reis et al. [20], healthy young adults generally complete the TGlittre in an average of 2 min, while Valadares et al. [11] showed that patients with heart failure spend an average of 6.3 min, confirming that

healthy individuals take less time to complete the test than individuals with cardiopulmonary diseases.

In the present study, individuals with COPD displayed similar final physiological responses in the 6MWT and TGlittre, except HR (96.4 ± 16.2 bpm vs. 106.7 ± 21.9 bpm). Saglam et al. [21], Van Gestel et al. [22] and Souza et al. [23] reported metabolic, ventilatory and cardiovascular responses in elderly with COPD, and healthy seniors submitted to physical exertion tests have demonstrated that cardiovascular function plays a significant role in exercise tolerance. These data are also confirmed by Someya et al. [24], who compared the performance of healthy elderly in the 6MWT to that of young adults, showing a correlation between the distance walked in the 6MWT and HR-based cardiac output, but with no intergroup difference in distance walked in the 6MWT. In addition, Souza et al. [23] also demonstrated that individuals with severe COPD have lower metabolic and cardiac reserves, differentiating them from individuals with the mild form.

Karloh et al. [25], Vaes et al. [26] and Cavalheri et al. [27] showed that patients with COPD exhibit similar cardiovascular demand, but higher metabolic load and perceived dyspnea than those of healthy seniors during physical exertion. In addition to the difference between final HR in the 6MWT and TGlittre, the present study also demonstrated a correlation between final HR in both tests ($r = 0.69$, $p = 0.002$), confirming the greater overload in the TGlittre. These findings corroborate the results of Karloh et al. [28], who investigated the physiological responses of the TGlittre compared to the 6MWT in seniors with COPD and found that basic cardiopulmonary variables behaved similarly in the two tests, but TGlittre induced higher final oxygen intake than the 6MWT (1329 ± 3.14 mL/min vs. 1246 ± 3.24 mL/min).

This greater overload in TGlittre may be due to the fact that this test involves activities with higher physiological demand, as demonstrated by Cavalheri et al. [28], who compared five activities individually, based on the TGlittre protocol, performed for one minute each, and observed that going up and down stairs burned more calories than walking and caused considerable fatigue and dyspnea in subjects with COPD. Gulart et al. [29] also assessed separate TGlittre activities and found that walking on a flat surface and moving objects on a shelf caused greater metabolic and ventilatory demand than rising from a sitting position, albeit with no differences in going up and down stairs.

Exercise intolerance mechanisms in individuals with COPD are heterogeneous. In this context, Rausch-Osthoff et al. [16] assessed the influence of peripheral muscle strength on the functional capacity (measured by the 6MWT, rising from a sitting position test and dynamometry) and ADL (measured by accelerometry) of seniors with COPD, concluding that peripheral muscle strength may be associated with functional capacity, but not ADL. Calik-Kutukcu et al. [30] compared peripheral muscle strength, exercise capacity, perceived fatigue and quality of life between patients with COPD and healthy individuals and observed a decline in all the measures studied, in addition to high perceived dyspnea and fatigue during ADL in relation to controls, which demonstrates the need for a comprehensive test able to assess all the systems potentially involved.

According to Kocks et al. [8], both the 6MWT and TGlittre are considered good tools to assess capacity and functional performance, the former widely used clinically. However, the 6MWT does not identify deficits in upper arm activities, while the TGlittre measures functional performance using upper and lower limb activities. Gulart et al. [31] investigated the correlation between functional capacity assessed by the 6MWT and TGlittre, and perceived limitations in ADL, measured by the London Chest Activity of Daily Living (LCADL) scale, in patients with COPD. The authors concluded that both the 6MWT and TGlittre reflect limitations in ADL; however, the latter explained 44% of variability in LCADL and seems to be more sensitive in reflecting the perceived functional impairment in this population.

Some of the study limitations should be mentioned. Although the sample universe was ample, a limited number of patients were allocated to the study, precluding discriminating between different degrees of COPD with the variables studied. Many patients recruited from the institution faced socioeconomic difficulties in monitoring and controlling the disease, but the results were consistent and seem representative for this group. Another limitation is the fact that the researchers were unable to conduct a maximum incremental exercise test in order to obtain the maximum metabolic, ventilatory and cardiovascular variables as comparative parameters between the tests. A further limitation is the absence of a non-rehabilitated group of seniors with COPD and a control group of healthy individuals for comparison purposes and to better specify the functional limitations of the study population.

Conclusion

The TGlittre is apparently able to induce a greater work overload than the 6MWT in elderly with COPD. This is because the activities involved require higher energy expenditure and greater cardiovascular strain, reflected in the increased heart rate. However, no differences were observed in the other variables studied, reinforcing the need for more detailed studies in the field in order to obtain more knowledge about the tests used to assess capacity and the functional performance of elderly with COPD. In addition, the results of both tests show that the population studied exhibits restrictions in performing ADL, and should be referred to a pulmonary rehabilitation program.

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References

- Global Initiative for Chronic Obstructive Lung Disease. Global strategy for the diagnosis, management and prevention of Chronic Obstructive Pulmonary Disease. 2018 [cited 2018 Jul 2]. Available from: <http://www.goldcopd.org>.
- Menezes AM, Jardim JR, Pérez-Padilla R, Camelier A, Rosa F, Nascimento O, et al. Prevalence of chronic obstructive pulmonary disease and associated factors: the PLATINO Study in São Paulo, Brazil. *Cad Saude Publica*. 2005;21(5):1565-73.
- Moreira GL, Manzano AM, Gazzotti MR, Nascimento OA, Pérez-Padilla R, Menezes AM, et al. PLATINO, a nine-year follow-up study of COPD in the city of São Paulo, Brazil: the problem of underdiagnosis. *J Bras Pneumol*. 2014;40(1):30-7.
- Evans RA, Morgan MDL. The systemic nature of chronic lung disease. *Clin Chest Med*. 2014;35(2):283-93.
- Smith BM, Jensen D, Brosseau M, Benedetti A, Coxson HO, Bourbeau J. Impact of pulmonary emphysema on exercise capacity and its physiological determinants in chronic obstructive pulmonary disease. *Sci Rep*. 2018;8(1):15745.
- Maltais F, Decramer M, Casaburi R, Barreiro E, Burelle Y, Debigaré R, et al. An Official American Thoracic Society/ European Respiratory Society statement: update on limb muscle dysfunction in Chronic Obstructive Pulmonary Disease. *Am J Respir Crit Care Med*. 2014;189(9):e15-62.
- Walsh JR, Morris NR, McKeough ZJ, Yerkovich ST, Paratz JD. A simple clinical measure of quadriceps muscle strength identifies responders to pulmonary rehabilitation. *Pulm Med*. 2014;2014:782702.
- Kocks JW, Asijee GM, Tsiligianni IG, Kerstjens HA, van der Molen T. Functional status measurement in COPD: a review of available methods and their feasibility in primary care. *Prim Care Respir J*. 2011;20(3):269-75.
- Ross RM, Murthy JN, Wollak ID, Jackson AS. The Six Minute Walk test accurately estimates mean peak oxygen uptake. *BMC Pulm Med*. 2010;10:31.
- Skumlien S, Hagelund T, Bjørtuft O, Ryg MS. A field test of functional status as performance of activities of daily living in COPD patients. *Respir Med*. 2006;100(2):316-23.
- Valadares YD, Corrêa KS, Silva BO, Araujo CLP, Karloh M, Mayer AF. Aplicabilidade de testes de atividades de vida diária em indivíduos com insuficiência cardíaca. *Rev Bras Med Esporte*. 2011;17(5):310-4.
- Vandenbroucke JP, Von Elm E, Altman DG, Gøtzsche PC, Mulrow CD, Pocock SJ, et al. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *Epidemiology*. 2007;18:805-35.
- Holland AE, Spruit MA, Troosters T, Puhan MA, Pepin V, Saey D, et al. An official European Respiratory Society/ American Thoracic Society technical standard: field walking tests in chronic respiratory disease. *Eur Respir J*. 2014;44(6):1428-46.
- Borg GA. Psychophysical bases of perceived exertion. *Med Sci Sports Exerc*. 1982;14(5):377-81.
- Hulley SB, Cummings SR, Browner WS, Grady D, Hearst N, Newman TB. *Delineando a pesquisa clínica: uma abordagem epidemiológica*. 2nd ed. Porto Alegre: Artmed; 2003.
- Rausch-Osthoff AK, Kohler M, Sievi NA, Clarenbach CF, van Gestel AJ. Association between peripheral muscle strength, exercise performance, and physical activity in daily life in patients with Chronic Obstructive Pulmonary Disease. *Multidiscip Respir Med*. 2014;9(1):37.

17. Mazzocchi CS, Costa CC, Canterle DB, Moussalle LD, Colombo C, Teixeira PJZ. Comparação das variáveis fisiológicas no teste de caminhada de seis minutos e no teste da escada em portadores de doença pulmonar obstrutiva crônica. *Rev Bras Med Esporte*. 2012;18(5):296-9.
18. Gulart AA, Munari AB, Klein SR, Silveira LS, Mayer AF. The Glittre-ADL test cut-off point to discriminate abnormal functional capacity in patients with COPD. *COPD*. 2018;15(1):73-8.
19. Corrêa KS, Karloh M, Martins LQ, Santos K, Mayer AF. O teste de AVD Glittre é capaz de diferenciar a capacidade funcional de indivíduos com DPOC da de saudáveis. *Rev Bras Fisioter*. 2011;15(6):467-73.
20. Reis CM, Silva TC, Karloh M, Araujo CLP, Gulart AA, Mayer AFL. Performance of healthy adult subjects in Glittre ADL-test. *Fisioter Pesqui*. 2015;22(1):41-7.
21. Saglam M, Vardar-Yagli N, Savci S, Inal-Ince D, Calik-Kutukcu E, Arikan H, et al. Functional capacity, physical activity, and quality of life in hypoxemic patients with chronic obstructive pulmonary disease. *Int J Chron Obstruct Pulmon Dis*. 2015;10:423-8.
22. van Gestel AJR, Baty F, Rausch-Osthof AK, Brutsche MH. Cardiopulmonary and gas-exchange responses during the six-minute walk test in patients with chronic obstructive pulmonary disease. *Respiration*. 2014;88(4):307-14.
23. Souza GF, Moreira GL, Tufanin A, Gazzotti MR, Castro AA, Jardim JR, et al. Physiological requirements to perform the Glittre Activities of Daily Living test by subjects with mild-to-severe COPD. *Respir Care*. 2017;62(8):1049-57.
24. Someya F, Mugii N, Oohata S. Cardiac hemodynamic response to the 6-minute walk test in young adults and the elderly. *BMC Res Notes*. 2015;8:355.
25. Karloh M, Corrêa KS, Martins LQ, Araujo CL, Matte DL, Mayer AF. Chester step test: assessment of functional capacity and magnitude of cardiorespiratory response in patients with COPD and healthy subjects. *Braz J Phys Ther*. 2013;17(3):227-35.
26. Vaes AW, Wouters EFM, Franssen FME, Uszko-Lencer NHMK, Stakenborg KHP, Westra M, et al. Task-related oxygen uptake during domestic activities of daily life in patients with COPD and healthy elderly subjects. *Chest*. 2011;140(4):970-9.
27. Cavalheri V, Donária L, Ferreira T, Finatti M, Camillo CA, Ramos EMC, et al. Energy expenditure during daily activities as measured by two motion sensors in patients with COPD. *Respir Med*. 2011;105(6):922-9.
28. Karloh M, Karsten M, Pissaia FV, Araujo CL, Mayer AF. Physiological responses to the Glittre-ADL test in patients with chronic obstructive pulmonary disease. *J Rehabil Med*. 2014;46(1):88-94.
29. Gulart AA, Munari AB, Tressoldi C, Santos K, Karloh M, Mayer AF. Glittre-ADL multiple tasks induce similar dynamic hyperinflation with different metabolic and ventilatory demands in patients with COPD. *J Cardiopulm Rehabil Prev*. 2017;37(6):450-3.
30. Calik-Kutukcu E, Savci S, Saglam M, Vardar-Yagli N, Inal-Ince D, Arikan H, et al. A comparison of muscle strength and endurance, exercise capacity, fatigue perception and quality of life in patients with chronic obstructive pulmonary disease and healthy subjects: a cross-sectional study. *BMC Pulm Med*. 2014;14:6.
31. Gulart AA, Santos K, Munari AB, Karloh M, Cani KC, Mayer AF. Relação entre a capacidade funcional e a percepção de limitação em atividades de vida diária de pacientes com DPOC. *Fisioter Pesqui*. 2015;22(2):104-11.

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