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ORIGINAL ARTICLE

Can the Glittre ADL test differentiate the functional capacity of COPD patients from that of healthy subjects?

O teste de AVD-Glittre é capaz de diferenciar a capacidade funcional de indivíduos com DPOC da de saudáveis?

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Abstract

Background: The Glittre ADL (TGlittre) test is a specifically designed to assess functional limitation in chronic obstructive pulmonary disease (COPD) patients. However, it is not known if it can differentiate the performance of these patients from healthy subjects. **Objectives:** To investigate whether the Glittre ADL test is able to differentiate the functional capacity of COPD patients from that of healthy subjects and to compare the cardiorespiratory response between Glittre ADL and the six-minute walk test (6MWT). **Methods:** The study included 10 patients with COPD (GOLD 2 to 4) and 10 healthy subjects matched by age who performed the following: spirometry pre-and post-bronchodilator, a Glittre ADL test and two 6MWT on two consecutive days. **Results:** The performance of COPD (FEV_1%pred= 38.1±11.8, age=64±10 years, BMI=23.7±5.2 kg/ m^2) was worse than the control group on TGlittre (5.26±2.9 min, 3.3±0.3 min, p<0.05) and 6MWT (434.97±105.18 m vs. 593.25±87.36 m, p<0.05). TGlittre correlated with the physical activity domain of the London Chest Activity of Daily Living (LCADL) scale (r=0.67, p<0.05) and with 6MWT when the total sample was analyzed (r=-0.64, p<0.05). The COPD group had a statistically higher (p<0.05) increase in dyspnea (Borg scale) than the control group for both TGlittre and 6MWT, with a similar heart rate and peripheral oxygen saturation variation in both groups (p>0.05). **Conclusions:** The performance of COPD patients is worse than that of healthy subjects on the Glittre ADL test, with a greater increase in dyspnea and similar heart rates.

Keywords: evaluation; rehabilitation; activities of daily living; pulmonary disease, chronic obstructive.

Resumo

Contextualização: O teste de AVD Glittre (TGlittre) é um teste específico desenvolvido para avaliar a limitação funcional em pacientes com doença pulmonar obstrutiva crônica (DPOC), no entanto não se sabe qual sua capacidade de diferenciar o desempenho de doentes do de indivíduos saudáveis. **Objetivos:** Investigar se o TGlittre é capaz de diferenciar a capacidade funcional de pacientes com DPOC da de indivíduos normais, além de comparar a resposta cardiorrespiratória induzida pelo TGlittre com a do teste de caminhada de seis minutos (TC6min). **Métodos**: Participaram do estudo dez indivíduos com DPOC (GOLD 2 a 4) e dez indivíduos saudáveis de mesma faixa etária, realizando as seguintes avaliações: espirometria pré e pós-broncodilatador; um TGlittre e dois TC6min em dois dias consecutivos. **Resultados:** O grupo DPOC (VEF_1%prev = 38,1±11,8, idade = 64±10 anos) apresentou pior desempenho que o grupo controle no TGlittre (5,26±2,9 min vs. 3,3±0,3 min, p<0,05) e no TC6min (434,97±105,18 m vs. 593,25±87,36 m, p<0,05). O TGlittre correlacionou-se com o domínio atividade física da escala *London Chest Activity of Daily Living* (LCADL) (r=0,67, p<0,05) no grupo DPOC e com o TC6min na amostra total (r=-0,64; p<0,05). Tanto no TGlittre como no TC6min, o grupo DPOC registrou aumento da dispneia (Borg) estatisticamente maior (p<0,05) que no grupo controle, com frequência cardíaca e saturação periférica de oxigênio similares (p>0,05). **Conclusões:** Pacientes com DPOC têm pior desempenho que indivíduos saudáveis no TGlittre, com maior dispneia e frequência cardíaca similar.

Palavras-chave: avaliação; reabilitação; atividades cotidianas; doença pulmonar obstrutiva crônica.

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Introduction

Exercise Intolerance is a common manifestation in patients with chronic obstructive pulmonary disease (COPD), contributing to the loss of functional capacity and interfering with the ability to perform activities of daily living (ADL)[1-3]. The reduction in exercise tolerance is related to several factors, including airflow limitation, inefficient gas exchange, peripheral muscle weakness[4,5], alterations in metabolism and the composition of peripheral muscles[6,7].

Functional capacity and limitations in performing ADL are better predicted by global tests, which reproduce daily activities, than by tests focused on isolated components of functional activity[8]. The six-minute walk test (6MWT) and the Glittre ADL test (TGlittre) can reflect the functional limitations of patients with COPD[1,8,9]. TGlittre was proposed to evaluate essential ADL in patients with COPD and it may be considered more complete than the 6MWT for evaluating these individuals' functional capacity, especially that of more compromised patients, because it involves, besides walking, activities such as sitting and rising from a chair, ascending and descending steps and arm movements while carrying weight[1,9]. This test is reproducible, quick and easy to apply and responsive to a pulmonary rehabilitation program[1]. Skumlien et al.[1] report that more than half of their sample showed a test time less than or equal to 4 minutes, with a mean time of 4.67 (2.7-14.47) minutes. These authors reported that 2 minutes is the shortest time in which healthy individuals could complete the test without violating the protocol. Nevertheless, the above-mentioned study tested only individuals with COPD, with no healthy control group for comparison of performance or cardiorespiratory response induced by the test. In TGlittre, as well as in 6MWT, the test rhythm is governed by the patients[1] and, thus, it is hypothesized that this rhythm induces a cardiorespiratory response similar that of 6MWT.

The present study aims to investigate whether TGlittre can differentiate the functional capacity and cardiorespiratory response of patients with COPD from those healthy individuals, using 6MWT as a functional performance standard.

Methods

Subjects

Ten individuals with COPD (GOLD 2-4)[10], who were recruited from the database of the Hospital das Clínicas of the Universidade Federal de Uberlândia (UFU), Uberlândia, MG, Brazil, and ten healthy individuals paired by gender, age and body mass index (BMI), who were recruited from the community, participated in the study. The inclusion criteria for the COPD group were: diagnosis of COPD based on clinical and spirometric criteria[10], tobacco intake above 20 pack-years, clinical stability in the month prior to the beginning of the protocol and being over 40 years of age. Sedentary individuals over 40 years old with normal spirometry and no history of smoking were included in the control group. Patients on home oxygen therapy, with cardiomyopathy, musculoskeletal diseases, rheumatic diseases, obesity, cancer, diabetes mellitus, tuberculosis and asthma, users of orthopedic prostheses or unable to perform the tests, as well as individuals whose clinical status became exacerbated during the data collection period were excluded from the study.

This was a descriptive cross-sectional study that had been previously approved by the Ethics in Human Research Committee of the Centro Universitário do Triângulo (UNITRI), Uberlândia, MG, Brazil (protocol 618161). The participants of the study signed a term of informed consent.

Pulmonary function

A previously calibrated *EasyOne* (NDD, Switzerland) spirometer was used to evaluate pulmonary function. The methods and criteria followed ATS/ERS recommendations[11]. The patients' weight and height were measured. Spirometry measures were obtained both before and 15 minutes after the inhalation of 400 μg of salbutamol. Forced expiratory volume in the first second in absolute value (FEV_1) and in percentage of predicted value (FEV_1% pred), forced vital capacity (FVC) and the FEV_1/FVC ratio were evaluated. The predicted values were established by Pereira, Sato and Rodrigues[12].

Functional capacity

Glittre ADL test

The TGlittre test consists of the following: while wearing a backpack with a load of 2.5 kg for women and 5 kg for men, subjects start from a sitting position, walk on a flat 10 m course, ascend and descend two steps (17 cm high x 27 cm wide) located in the middle of the course, face two shelves upon arrival at the end of the course, in which the upper (shoulder height) contains three 1 kg objects; the objects are to be moved one by one to the lower shelf (waist height) and then to the ground, after which they must be placed again on the lower shelf and then on the higher shelf; the individual then returns, following the course to the original position and another lap immediately follows as described above. A total of five laps must be completed in the shortest possible time. Heart rate (HR) (Polar S625X), peripheral oxygen saturation (SpO_2) (305A portable oximeter ResMed) and dyspnea index

(Modified Borg Scale[13]) were measured at the beginning of the test, between laps and at the end of the test. No verbal incentive was offered during this test.

Six-minute walk test

According to the *American Thoracic Society* recommendations[14], the 6MWT was performed in a level 30 m corridor that was marked at each meter. The individuals were instructed to walk as far as possible and received standardized verbal incentive. HR, SpO_2, and dyspnea index[13] were measured at the beginning, at the 2nd and 4th minutes and again at the end of the test. Two tests were performed with a 30 min interval between them. The greatest distance walked and the predicted value for the test[15] were considered for analysis.

TGlittre and 6MWT were interrupted if the patient reported chest pain, intolerable dyspnea, lower limb cramps, vertigo, intense sweating or became pale[14]. Falls in SpO_2 below 90% or ≥4% in basal SpO_2, maintained between 90 and 94%[16], were considered as desaturation.

Functional status

Functional status was evaluated with the *London Chest Activity of Daily Living* (LCADL) scale, which was proposed and validated for individuals with COPD by Garrod et al.[17] and was translated into Portuguese by Carpes et al.[18]. Its categories include personal care, household activities, physical activities and leisure, and it allows evaluation of the of patient's dyspnea level and response to therapeutic intervention[17,19]. The LCADL scale involves ADLs such as putting on a shirt, making a bed, etc. It has a total of 15 quantitative questions in which patients can score from 0 to 5 points, thus allowing a maximum score of 75 points ($LCADL_{total}$)[17]. The percentage of the total score was also calculated ($LCADL_{\%total}$), not considering items for which the answer was zero[18].

Physical activity level

The physical activity level of the control group was evaluated with the Modified Baecke questionnaire for the elderly[20], which investigates habitual physical activities carried out over the last year. It has questions about the type of activities performed and the number of hours per week and months per year in which these activities were usually performed[20,21]. A score below 9.4 classifies the individual as sedentary[21].

Statistical analysis

The Shapiro-Wilk normality test was applied and, according to the nature of the variables, the corresponding parametric or non-parametric test was used. The independent *t*-test was used to compare 6MWT performance, spirometric variables and variation in HR and SpO_2 between the COPD and control groups. The Mann-Whitney U test was used to compare the performance on TGlittre, FEV_1%pred and dyspnea index between groups.

The Pearson Correlation Coefficient was used to correlate test performance by the COPD group and to determine correlations between pulmonary function, age, weight, height and BMI. The Spearman Correlation was used for associations between control group test performance, the total sample and between scales (LCADL, Borg) and the other variables.

The data are shown as mean, standard deviation, median and confidence interval. The level of significance was set at 5%.

Results

All ten individuals concluded the protocol in the COPD group, which included seven females and three males. The control group had the same gender distribution. The characteristics of both groups are shown in Table 1. The groups did not differ in age, body mass, height or BMI, but showed differences in pulmonary function and tobacco intake ($p<0.05$). In the control group, the Baecke score ranged between 3.0 and 8.3, with a median of 4.5.

In the COPD group, a moderate negative correlation was verified between $LCADL_{\%total}$ and FEV_1%pred ($r=-0.642$, $p=0.04$) and between the physical activity domain of the LCADL scale and the time necessary to complete TGlittre ($r=0.67$, $p=0.03$). The total score and percentage of LCADL total was not correlated with TGlittre.

The performance of individuals with COPD on both the ADL and walking tests was worse ($p<0.05$) than controls (Table 2). The COPD group spent 161% of the time spent by the control group to complete TGlittre and walked 70% of the distance in 6MWT. The distance walked in 6MWT was equal to 77±15% of that predicted in the COPD group and to 106±19.9% of the predicted in the control group.

HR behavior was similar in both groups during TGlittre, demonstrating a physiological increase. Regarding the 6MWT, despite not having reached statistical significance, the variation in HR tended to be lower in the COPD group. SpO_2, however, showed a significantly greater reduction in both tests in the COPD group, although the variation in SpO_2 (final SpO_2 minus the at-rest value) only differed between groups for 6MWT ($p=0.01$) (Table 2). Dyspnea variation was higher in the COPD group, both for TGlittre ($p=0.04$) and 6MWT ($p=0.01$) (Table 2). The increase in HR and dyspnea and the reduction in SpO_2 were similar for both tests in the COPD

Table 1. Characteristics of patients.

	Control group (n=10)	COPD group (n=10)	p
Age (years)	63±7 (49.4/77.5)	64±10 (44/84.4)	0.86
Sex	7 (F) e 3 (M)	7 (F) e 3 (M)	
Pack-years	0±0 (0/0)	63±42 (19.7/146.6)	<0.01
Body mass (kg)	61.0±7.9 (55.3/66.7)	59.1±12.2 (50.4/67.8)	0.68
Hight (m)	1.57±5.85 (1.46/1.7)	1.57±8.83 (1.4/1.7)	0.86
BMI (kg/m^2)	24.5±3.1 (18.5/30.5)	23.7±5.1 (13.7/33.7)	0.67
FEV_1(liters)	2.8±0.5 (1.99/2.75)	0.9±0.2 (0.76/1.08)	<0.01
FEV_1 (%pred)	95.8±18.0 (82.89/108.71)	38.1±11.8 (29.63/46.57)	<0.01
FVC (liters)	2.8±0.7 (2.30/3.32)	1.9±0.4 (1.57/2.20)	<0.01
FVC (%pred)	96.4±20.4 (81.84/110.96)	61.1±12.5 (52.11/70.09)	<0.01
FEV_1/FVC (%)	85.0±4.4 (81.91/88.16)	48.4±7.8 (42.84/54.06)	<0.01
LCADL		22.6±4.6 (13.5/31.7)	
Self-care		6.2±1.5 (3.2/9.2)	
Domestic		7.8±3.6 (0.8/14.8)	
Physical		4.4±1.1 (2.0/6.4)	
Leisure		4.2±1.1 (2.0/6.4)	
$LCADL_{\%total}$		33.3±5.7 (22.2/44.5)	

COPD=chronic obstructive pulmonary disease; Mean±SD (95%CI): p=significance level; BMI=body mass index; F=female; M=male; FEV_1=forced expiratory volume in one second; FEV_1%pred=percentage of predicted expiratory volume in one second; FVC=forced vital capacity; FVC%pred=percentage of predicted forced vital capacity; LCADL=total score of the London Chest Activity of Daily Living scale; $LCADL_{\%total}$=percentage of the total score of the London Chest Activity of Daily Living scale.

Table 2. Comparison between performance and vital signs behavior in functional capacity and exercise tests.

	Control group	COPD group	p
Glittre ADL-test			
Time spent (min)	3.3±0.3 (2.8-3.8)	5.3±2.9 (3.2-11.3)	0.02
Δ HR	39.2±15.4 (116.2-77.0)	31.6±12.4 (115.8-84.2)	0.24
Δ SpO_2	-3.2±1.8 (92.5-95.7)	-8.4±8.1 (84.1-92.5)	0.06
Δ Borg	1.8±0.9 (0-3.0)	3.7±2.6 (0.5-9.0)	0.04
6MWT			
Distance walked (m)	593.2±87.4 (434.0-766.0)	434.9±105.2 (226.0-561.0)	<0.01
Δ HR	39.1±17.3 (124.0-84.9)	26.9±11.6 (113.2-87.5)	0.08
Δ SpO_2	-1.8±1.4 (93.9-95.7)	-8.1±7.4 (84.1- 92.1)	0.01
Δ Borg	1.3±0.9 (0.5-8.0)	3.7±2.6 (0-3.0)	0.01

Mean±SD (CI); p=level of significance; Glittre ADL-test (min)=time spent on Glittre ADL-test in minutes; 6MWT (m)=distance walked during the six-minute walk test in meters; Δ=change (final value-initial); HR=heart rate; SpO_2=saturation of peripheral oxygen (SpO_2); Borg dyspnea scale.

and control groups (p>0.05). In the COPD group, there were strong correlations between HR variation, SpO_2 and dyspnea index in both tests (ΔFC-TGlittre *vs* ΔFC-6MWT r=0.848; ΔSpO_2-TGlittre *vs* ΔSpO_2-6MWT r=0.784; ΔBorg-TGlittre *vs* ΔBorg-6MWT r=0.947; p<0.01).

In the COPD group, the time spent on TGlittre was associated with age (r=0.66, p=0.03), but was correlated with neither degree of pulmonary obstruction (VEF_1) nor distance in 6MWT. Although there was no correlation between TGlittre and 6MWT in the COPD and control groups (r=-0.39 and r=-0.62 respectively; p>0.05), when both groups were analyzed together (n=20), there was a moderate correlation between TGlittre and 6MWT (r=-0.64,p=0.002, Figure 1).

Discussion

The present study aimed to investigate whether TGlittre can differentiate the functional capacity of patients with COPD from healthy individuals. There is no gold standard for evaluating the functional capacity of either healthy individuals[22] or those with COPD[17]. The LCADL scale is specifically designed to evaluate functional status, considering dyspnea during ADL in individuals with COPD[17] such that the higher the score, the greater the individual's limitation. Carpes et al.[18] observed an association between LCADL score, degree of obstruction and 6MWT performance. In the present study, there was also a negative correlation between

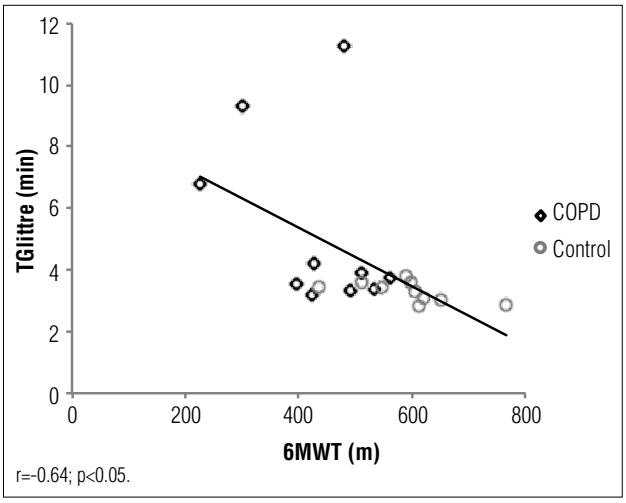

Figure 1. Correlation between the time spent in the Glittre ADL-test (min) and distance walked during the six-minute walk test (6MWT).

$LCADL_{\%total}$ and degree of pulmonary obstruction, although there was no association between the LCADL score and distance walked in the 6MWT, probably due to the reduced sample size (type II error)[23].

It has been previously demonstrated that a score over 50% in the $LCADL_{\%total}$ scale indicates severe ADL limitations[24]. In the present study, the mean score was 33.3% and, therefore, in spite of severe airflow obstruction, the sample did not show severe ADL limitations. This may explain why patients with COPD walked, on average, 100 m more in 6MWT than those in Carpes et al.[18], who were also 10 percent higher on the $LCADL_{\%total}$ scale (45.4%) than the COPD group in the present study. There was also no correlation between LCADL scale and TGlittre scores, although both are intended to evaluate ADL. This may have occurred because the former instrument relies on the subject's memory to evaluate four sections of the individual's daily life, while the second directly evaluates limitations by executing ADL-type activities.

ADL may be evaluated and quantified by direct observation, questionnaires, motion sensors[25] and field tests[2]. Subjects may be observed directly or in video recordings to quantify the performed activities. Questionnaires or scales are inexpensive methods that are easy to apply, but are subjective and have low accuracy[25]. In Brazil, the LCADL scale[18,26] and the *Pulmonary Functional Status and Dyspnea Questionnaire*[27] are two available instruments that have been validated in Portuguese. Motion sensors detect body movements and may be used to objectively quantify activities of daily living[25]. The available field tests for evaluating ADL usually involve only one type of activity instead of a variety of activities, as is common in daily life. The 6MWT, for instance, is a test that reflects ADL[8,14] using only horizontal displacement on a level surface. The *sit-to-stand* test specifically evaluates the activity of sitting and rising from a chair and showed an association with 6MWT in patients with COPD[28]. TGlittre was developed and validated for evaluating daily activities that usually cause greater limitations in these patients[1]. Therefore, the lack of association between scales and direct evaluations could be explained by the different nature of the information collected. However, the possibility that a type II error occurred cannot be discarded since this association was only verified in the COPD group (n=10). In spite of the lack of association between TGlittre and $LCADL_{total}$, a moderate correlation was observed between the physical activity domain of the LCADL scale and the time spent on TGlittre. This domain asks about the capacity to perform some activities that are reproduced in TGlittre, such as ascending and descending stairs and bending, which might have favored this result.

There was no association between pulmonary obstruction degree (FEV_1) and exercise capacity in the COPD group. This variable alone is not a good predictor of physical capacity in patients with COPD[29]. According to these authors, the BODE mortality index, since it includes multiple components, would be more appropriate for estimating the level of physical activity. However, due to the reduced sample size, it was not possible to verify this association in the present study.

When comparing performance on functional capacity tests between COPD patients and healthy sedentary individuals of the same age group, it was verified that the COPD group performance was worse on both tests. The debilitation of COPD patients becomes more evident when considering 6MWT predicted values. The COPD group distances were below those predicted, while the control group distances were greater. Skumlien et al.[1] observed an association between the time spent on TGlittre and the distance walked in 6MWT in COPD patients (r=-0.82, p<0.05), which did not occur in the present study. They observed this correlation especially in individuals who walked greater distances (between 500 and 700 m). In the present study, patients with COPD walked, on average, 435m, which might have prevented any association. In the group control, who walked greater distances (mean of 593m), a tendency toward this correlation was observed. This may suggest the occurrence of a type II error, given that when all individuals were included in the analysis such an association was observed. Figure 1 shows that the best correlations between TGlittre and 6MWT were those observed in individuals who walked greater distances during the 6MWT, a phenomenon also observed by Skumlien et al.[1]. Thus, groups that walk shorter distances in the 6MWT probably do not show an association between these two variables.

In a TGlittre study by Skumlien et al.[1] that included only individuals with COPD, the test was validated as an instrument

for evaluating their functional capacity. However, studies that have applied this test to healthy individuals of the same age group were not taken into account to compare the time necessary for a healthy individual of the same age to complete the test. Individuals in the COPD group completed the test in approximately 160% of the time spent by healthy individuals and they also showed significant variations in HR, SpO_2 and dyspnea index that were very similar to those observed in 6MWT.

HR behavior was similar in both groups for both the TGlittre test and the 6MWT. There was a significant increase in heart rate in both groups at the end of both tests that did not vary between groups. HR increase is an expected physiological result when metabolic demand increases during exercise because cardiac output increases to supply the need for peripheral oxygen. During exercise in a standing position, such as walking, the increase in cardiac output is due, initially, to increased HR and stroke volume. However, after having reached 110-120 beats per minute, the stroke volume stabilizes, and HR alone contributes to increased cardiac output[30]. The initial HR increase, until approximately 100 beats per minute, is due to the removal of the parasympathetic tonus; at higher rates of work, the sympathetic nervous system becomes responsible for its increase[31].

A greater desaturation was observed in the COPD group than in the control group in 6MWT ($p<0.05$). Perhaps with a larger sample the same effect would have been observed during the TGlittre test, since the variation in SpO_2 also tended to be higher in COPD patients. COPD patients are 18 times more likely to show desaturation during exercise than healthy individuals[32]. For these patients, a basal SpO_2 ≤95% can predict significant clinical desaturation during exercise with a sensitivity of 73%[33]. Nine out of the ten patients of the COPD group had a basal saturation below 95%. In both the 6MWT and TGlittre, seven out of the nine patients with a basal SpO_2 below 95% also had desaturation during the test.

The dyspnea score on the Borg scale ranged significantly between groups in both tests. There was no significant difference in its variation between tests, although some authors have reported that upper-limb activities with COPD patients provoke a greater degree of dyspnea than those that only use the lower limbs[34-36].

Some factors could be indicated as study limitations. First, the small sample size and the greater proportion of women may not reflect the real prevalence of COPD in the Brazilian population[37]. The sample size could also be a limiting factor since small samples may generate a low statistical power for associations (type II error). However, important associations were observed between the variables, which made it possible to clarify important subjects and contribute to new questions. In the studied sample, a mean difference of 2 minutes in TGlittre execution time was observed between COPD patients and healthy individuals. This value was above the clinically significant minimum value CI95% upper limit described by Skumlien et al.[1]. Some variables only showed a tendency to differ between groups, which should be better investigated in future studies. Another factor that could be identified as a limitation was the application of the physical activity questionnaire only to the control group. Although the questionnaire was not applied to the COPD group, the patients were systematically questioned whether they got regular physical activity. Moreover, patients in pulmonary rehabilitation programs were not recruited in order to avoid some bias. Furthermore, it is already known that individuals with COPD usually enter a vicious cycle of inactivity[8,29] and that they perform fewer daily movements than healthy sedentary individuals[8]. On the other hand, no study has attempted to discover the mean expected performance time of healthy individuals on TGlittre or the cardiorespiratory response induced by this test. We believe that this is a pioneer study and that its results may contribute to the development of future studies that evaluate the metabolic expenditure of individuals with COPD on the TGlittre test compared to the 6MWT at different severities of the disease. Although 6MWT reflects the functional capacity of COPD patients[8], it uses only walking, which may induce a metabolic expenditure and degree of dyspnea that are different from those induced by daily activities. TGlittre may be more complete in the evaluation of functional capacity, since it better mimics ADLs and, consequently, may more reliably portray the daily overload suffered by COPD patients.

In conclusion, in the studied sample, TGlittre proved effective at differentiating healthy individuals from those with COPD, whose performance was worse. COPD patients also showed greater dyspnea than in the 6MWT, although the heart rates were similar.

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