



## Is the six-minute walk test a useful tool to prescribe high-intensity exercise in patients with chronic obstructive pulmonary disease?



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### ABSTRACT

**Background:** It is not yet completely known whether the 6MWT can be used to prescribe high-intensity exercise for patients with COPD.

**Objective:** To evaluate the ability of the six-minute walk test (6MWT) to prescribe high-intensity exercise for patients with chronic obstructive pulmonary disease (COPD).

**Methods:** Lung function, maximal inspiratory strength, symptoms and exercise capacity were evaluated in patients with COPD ( $n = 27$ ) before and after a 12-week high-intensity exercise program. Criteria for high-intensity training were: 1)  $\geq 75\%$  of the 6MWT average speed; 2) American Thoracic Society/European Respiratory Society (ATS/ERS) criteria ( $\geq 60\%$  of the maximal incremental shuttle walk test speed). **Results:** The 6MWT showed good positive and negative predictive values (0.69 and 0.71, respectively), and accuracy (0.70), good reliability (ICC 0.70 [95%CI 0.45–0.85]) and moderate agreement ( $k$  0.41 [95%CI 0.13–0.67]) with the ATS/ERS criteria.

**Conclusion:** The 6MWT has good predictive ability and accuracy in relation to high-intensity exercise for patients with COPD.

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### Introduction

Despite improvements in quality of life and reduction in symptoms after low- or mild-intensity exercise training (ET) programs in patients with chronic obstructive pulmonary disease (COPD),<sup>1–3</sup> high-intensity ET programs are associated with more pronounced physiological improvements including increased exercise capacity and decreased ventilatory demand during exercise.<sup>3–5</sup> In addition to highlighting the central role of exercise

intensity in promoting these benefits,<sup>4</sup> this evidence highlights the need for an accurate and tailored prescription for exercise intensity.<sup>3</sup> Specific guidelines for patients with chronic lung diseases, such as COPD define high-intensity exercises as those performed at intensities  $\geq 60\%$  of the maximal exercise capacity.<sup>3</sup> Hence, there is a need for a test to determine the maximal exercise capacity of each patient and to guide the exercise prescription.

The cardio pulmonary exercise test (CPET), the gold standard for measuring maximal exercise capacity,<sup>6,7</sup> should be the first choice before the beginning of any high quality ET program. The incremental shuttle walk test (ISWT), a field walking test developed and validated for measuring maximal exercise capacity in this population, can also be used for the prescription of high-intensity ET.<sup>8,9</sup>

Despite its status as the gold standard method for the measurement of maximal exercise capacity,<sup>6,7</sup> the CPET is seldom available due to its complexity and the need for specialized personnel and equipment.<sup>6,7</sup> The ISWT also requires specialized personnel and equipment in order to manage adverse events

**Abbreviations:** 6MWT, six-minute walk test; 6MWT<sub>C</sub>, 6MWT criteria; 6MWT<sub>AS</sub>, average speed during the 6MWT; Borg<sub>C</sub>, Borg criteria; COPD, chronic obstructive pulmonary disease; CPET, cardio pulmonary exercise test; ET, exercise training; GOLD, global initiative for chronic obstructive pulmonary disease; ICC, intra-class correlation coefficient; ISWT<sub>C</sub>, ISWT criteria; ISWT<sub>S</sub>, speed achieved in the last stage of the ISWT; K, Cohen's kappa value; NPV, negative predictive value; PPV, positive predictive value; UEL, Universidade Estadual de Londrina; VO<sub>2</sub>, oxygen consumption; VO<sub>2</sub>max, maximum oxygen consumption.

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that may result from strenuous exercise associated with maximum effort.<sup>10</sup> Consequently, the use of the six-minute walk test (6MWT), a self-paced test performed at submaximal intensities,<sup>10</sup> has risen as an alternative to prescribe ET intensity in clinical and research settings.<sup>1,5,11,12</sup> The 6MWT is performed before exercise training programs worldwide because it is associated with outcomes such as mortality and hospitalization.<sup>10</sup> However, its use for the prescription of high-intensity ET has not been well documented or described in guidelines of ET prescription.<sup>3,13</sup>

Only one study was conducted to determine the extent to which the 6MWT is useful for prescribing high-intensity exercise for patients with COPD.<sup>14</sup> The conclusions of the cross-sectional study support the use of the 6MWT to support prescription of high-intensity ET for patients with COPD.<sup>14</sup> However, to the best of the authors' knowledge, its efficacy in a clinical setting during a high-intensity ET program has not been investigated. Thus, the aim of this study was to evaluate the extent to which the 6MWT detected high-intensity ET for patients with COPD during an outpatient high-intensity ET program. This was done by the evaluation of the predictive validity, agreement and reliability of 6MWT to detect whether or not the patient is exercising at an intensity  $\geq 60\%$  of the maximal exercise capacity. Because the use of the Borg scale is also suggested to guide exercise training intensity<sup>3</sup> its predictive validity and agreement to detect high-intensity exercise was also analyzed as a secondary results. The author's hypothesis was that the use of 6MWT would provide better results than the use of Borg scale, hence supporting its use in clinical practice.

## Methods

This longitudinal study was approved by the Research Ethics Committee of the University Hospital, State University of Londrina, Londrina, Brazil (N 123/09). Anthropometric data, lung function (spirometry), functional and maximal exercise capacity (6MWT and ISWT, respectively), dyspnea sensation in daily life (Medical Research Council Scale, MRC<sup>15</sup>), body composition (bioelectrical impedance), and inspiratory muscle strength [maximal inspiratory pressure (MIP)] were assessed before and after a 12-week high-intensity ET program. At the first and the 12th week of the ET program, data were collected on dyspnea and the sensation of fatigue (modified Borg scale), speed (km/h) and intensity relative to the 6MWT average speed (6MWT<sub>AS</sub>), and speed achieved in the last stage of the ISWT (ISWT<sub>S</sub>).

## Participants

Patients diagnosed with COPD according to the Global Initiative for chronic obstructive lung disease (GOLD)<sup>16</sup> criteria who satisfied the following inclusion criteria participated in the study: 1) stability (i.e., absence of exacerbations) for at least 3 months before entering the program; 2) absence of severe and/or unstable cardiovascular disease; 3) ability to perform the proposed assessments and activities; and 4) no participation in a formal ET program in the preceding year. The exclusion criteria were physical or cognitive inability to perform the proposed activities; development or diagnosis of other conditions/diseases that could influence the proposed activities and/or the results of the study. Patients who dropped out of the ET program due to severe acute exacerbation of COPD, hospitalization for any cause, severe unrelated health problems, lack of motivation and/or adherence, transportation difficulties or any personal reason, were excluded from the post-ET statistical analysis.

## Variables and measures

Lung function was assessed by spirometry<sup>17</sup> (Spirobank spirometer, version 3.6 MIR, Rome, Italy), and the reference values for the Brazilian population were used.<sup>18</sup> Inspiratory muscle strength was measured by MIP<sup>19</sup> (Makil®, Brazil), with reference values from Neder et al.<sup>20</sup> Functional exercise capacity by the 6MWT<sup>10</sup> in a 30 m flat corridor, and maximum exercise capacity by the ISWT<sup>10</sup> were also measured, whereas the national reference values considered were from Britto et al.<sup>21</sup> for the 6MWT and from Probst et al.<sup>22</sup> for the ISWT.

Dyspnea sensation in daily life was measured by the MRC scale<sup>15</sup> and body composition by bioelectrical impedance<sup>23</sup> (Biodynamics, EUA). Furthermore, in the first and last week of the ET program the following measurements were performed at the end of the exercise on treadmill: dyspnea and lower limb fatigue sensation by the modified 10-point Borg scale<sup>24</sup>; and speed performed by the patient during the ET (in km/h).<sup>1</sup>

## High-intensity exercise-training program

The 3-month high-intensity ET program consisted of whole-body endurance exercise performed on a cycle-ergometer and a treadmill plus upper and lower limbs strengthening exercises. For the cycle-ergometry training, the intensity was initially set at 60% of the maximal estimated work rate,<sup>25</sup> whereas for the treadmill walking was initially set at 75% of the 6MWT<sub>AS</sub>. For the cycle-ergometer and the treadmill, exercise duration was initially set at 10 min. The strength training intensity was initially set at 70% of the baseline one-repetition maximum test and performed in three series of eight repetitions. There was increase in training duration and intensity every week, guided by a pre-determined schedule and also driven by the patient's perception of symptoms (moderate-to-intense symptoms of dyspnea and fatigue according to the modified Borg score, i.e., between four and six).

## High-intensity exercise training criteria

According to international pulmonary rehabilitation guidelines,<sup>3</sup> the threshold for high-intensity exercise for patients with pulmonary diseases is 60% of the maximal exercise capacity. Despite the fact that other criteria are described in the literature,<sup>13,26</sup> this criterion was followed in this study because of its high acceptance in the COPD research field.<sup>3,5,9,27</sup> Therefore, exercise  $\geq 60\%$  of the ISWT<sub>S</sub> was used as the criterion for the ISWT criterion (ISWT<sub>C</sub>). For the 6MWT the cut-off of 75% of the 6MWT<sub>AS</sub>, as applied in previous studies,<sup>1,5,11,12</sup> was used as the 6MWT criterion (6MWT<sub>C</sub>) in the present analysis. Finally, another recommendation to guide high-intensity ET prescription is a value in the Borg scale between four and six during the ET sessions.<sup>3</sup> Accordingly, this was the cut-off considered for the Borg criterion (Borg<sub>C</sub>).

## Statistical analysis

Statistical analysis was performed with the Statistical Package of Social Science (SPSS) 17.0 (SPSS Inc., Chicago, IL, USA). Normality of the data was evaluated with the Shapiro–Wilk test. Normally distributed variables are expressed as mean  $\pm$  standard deviation (SD); non-normally distributed continuous variables as median (interquartile range, IQR); and categorical variables as number of cases and percentages [*n*, (%)].

The unpaired *t*-test or Mann–Whitney test was used for comparisons of pulmonary function, maximal inspiratory strength, symptoms, and exercise capacity between patients

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