

Development of a Dyspnoea Challenge: Comparison with the six minute walk test

Norman R. Morris, Pramod Sharma, Menaka Sabaratnam and Lewis Adams

Menzies Health Institute of Queensland and the School of Allied Health Sciences, Griffith University, QLD, Australia.

Background:

- Exertional breathlessness (dyspnoea) is a common symptom for patients with chronic lung disease. Patients often complain of worsening symptoms during short bouts of uphill walking such as stair climbing.
- Whilst several clinical tests measure breathlessness, there is currently no specific exercise test designed to measure breathlessness, during an uphill challenge
- The six minute walk test (6MWT) is the most common clinical exercise test for measuring exercise capacity in chronic lung disease patients (1). However the 6MWT is performed on a flat surface and the primary outcome is walk distance (6MWD) with breathlessness remaining a secondary outcome measure.

Study Aim:

- To develop a 2-minute uphill walking **dyspnoea challenge** test and to compare the breathlessness and exercise responses between the **dyspnoea challenge** and the 6MWT in a group of patients with mild, chronic lung disease.

Methods:

- 12 patients with mild, chronic lung disease participated in the study. For each volunteer, lung function (Medgraphics, Ultima CPX), quadriceps strength (Biodex System 4, Pro) and grip strength (Jaymar, Digital Plus) were also measured. Subject characteristics are presented in Table 1.
- Each participant completed two 6MWT as per recommended guidelines (1). Breathlessness, heart rate (HR), oxygen saturation (S_pO_2 , Nellcor) were recorded immediately prior and then every minute during the 6MWT. Leg fatigue (0-10) was recorded immediately prior and at the end of the test. For the purpose of this study, the highest value achieved in the repeat tests is reported.
- On separate days, each participant completed two dyspnoea challenge tests walking at 80% of the 6MWT speed at either a low incline or high incline. Details of the speed and incline are included in Table 2. Each test was separated by at least 30 minutes.
- During the dyspnoea challenge, dyspnoea, HR and S_pO_2 were recorded continuously and reported in 15 or 20 s intervals. Breathlessness was measured using a validated electronic 0-10 Scale (2). Participants were able to adjust this scale in 0.5 units using a mouse (Figure 1).
- Comparison between the 6MWT, the dysp_low and dysp_high tests were made using a one-way ANOVA with repeated measures. Probability of a type I error was set at 0.05.



Figure 1. Experimental setup.

Table 1. Subject Characteristics

Age (yr)	71 ± 4
Female/male	13/4
BMI (kg.m ⁻²)	26.6 ± 4.6
MRC Score	1.4 ± 1.0
BODE index	1.3 ± 1.4
Resting S_pO_2	99 ± 2
Handgrip Strength (kg)	24 ± 9 (61% pred)
Quads Strength (Nm)	97 ± 27
6MWD (m)	485 ± 67
SPIROMETRY	
FEV ₁ (%predicted)	70 ± 14
FVC (%predicted)	87 ± 13
FEV ₁ /FVC (%)	79 ± 13

Table 1. Mean ± SD. BMI: Body Mass Index; MRC: Medical Research Council Dyspnoea Scale; BODE: Body mass index, Obstruction, Dyspnoea, Exercise; S_pO_2 : Oxygen saturation; FEV₁: Forced Expired Volume in 1s; FVC: Forced Vital Capacity;

Table 2. Pre and End Test Data: 6MWT vs Dysp_Low and High

	6MWT	Dysp_Low	Dysp_High
Walk Speed (km.hr ⁻¹)	4.9 ± 0.7	3.9 ± 0.5	3.9 ± 0.5
Grade (%)	0	5.1 ± 1.9	9.3 ± 2.6
Pre test S_pO_2 (%)	99 ± 1	98 ± 1	99 ± 1
End test S_pO_2 (%)	95 ± 3	96 ± 2	97 ± 2
Pre test HR (beats/min)	89 ± 14	88 ± 12	86 ± 13
End test HR (beats/min)	117 ± 18	118 ± 12	125 ± 12
Pre test Dyspnoea	0.6 ± 0.8	0.5 ± 0.7	0.5 ± 0.5
End test Dyspnoea	4.9 ± 1.9	4.8 ± 2.3	6.6 ± 2.3*
Pre test Leg Fatigue	0.2 ± 0.8	0.4 ± 0.6	0.3 ± 0.7
End test Leg Fatigue	1.8 ± 2.2	2.8 ± 2.4	4.3 ± 3.2*

Table 2. Mean ± SD. 6MWT: Six minute walk test; Dysp_Low: Dyspnoea Challenge, low grade; Dysp_High: Dyspnoea Challenge, high grade; 6MWD: Six minute walk distance; S_pO_2 : oxygen saturation; HR: Heart Rate; * P<0.05, greater increase compared to 6MWT and Dyspn_Low.

Results:

- Each participant was able to complete the 6MWT and the dyspnoea challenge tests safely with no adverse events reported
- The degree of desaturation during each of the exercise tests was similar (Table 2).
- The change in leg fatigue tended to be greater for the dyspnoea challenge tests, with the dysp_high reporting the greatest increase (P<0.05, Table 2).
- The change in breathlessness over time are shown in Figure 2, panel A and Table 2. After 1 and 2 minutes of exercise there was a significant difference between tests, with the 6MWT having the lowest and the dyspn_high the greatest breathlessness scores. Overall, the dyspn_high had the greatest change in breathlessness score (Panel A) when compared breathlessness achieved at the end of the 6MWT and the dysp_low test (P<0.05).
- The change in heart rate is shown in Figure 2, Panel B. The HR followed a similar trend to dyspnoea. After 2 minutes there was a significant difference between tests, with the 6MWT having the lowest and the dysp_high the greatest dyspnoea scores. When compared with the HR achieved at the end of the 6MWT and the dysp_low, the dysp_high recorded the highest end exercise heart rate (P<0.05).

Figure 2 Change in Dyspnoea and HR During Exercise Tests

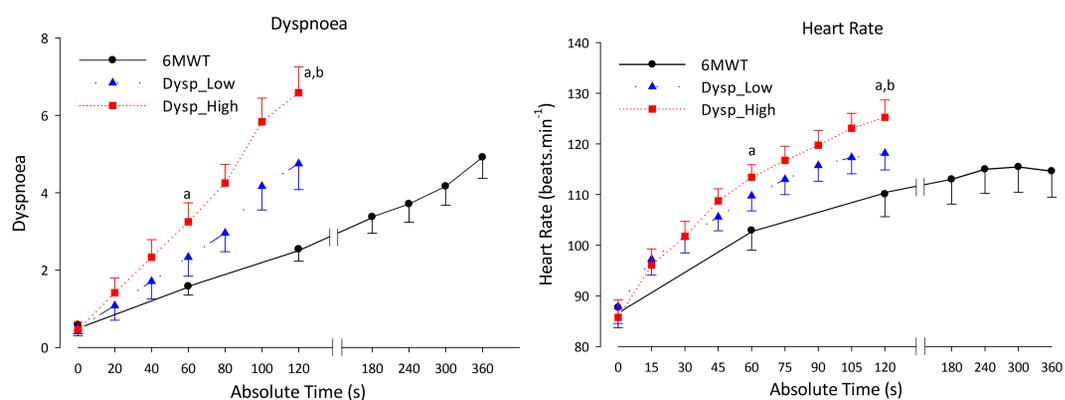


Figure 2. Change in Dyspnoea during the six minute walk test (6MWT) and the Low (Dysp_low) and High (Dysp_High) exercise tests. Panel A is a comparison of the dyspnoea scores measured over time and Panel B represents the change in Heart Rate over time. Data is mean ± SE. ^aP<0.01 significant difference between all exercise tests. ^bP<.05, Only Dysps_High significantly different to Dysp_Low and 6MWT at end test.

Conclusions:

- The dyspnoea challenge test is be feasible and simple to perform in a group of chronic lung disease patients with mild disease.
- Despite being shorter in duration, the dyspnoea_high test performed at approx. 9% grade, elicited a greater leg exertional breathlessness, leg fatigue and HR when compared to both the 6MWT and a 2-minute dyspnoea challenge performed at a lower grade.
- The dyspnoea_low, performed at approx. 5% grade and achieved a similar HR and breathlessness as the 6MWT.
- Further testing regarding the repeatability and the sensitivity of the dyspnoea challenge following an intervention are required if this test is to have broader clinical implementation.

References:

- Holland, A.E., 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): p. 1428-46.
- Morris, N.R., et al., Verbal numerical scales are as reliable and sensitive as visual analog scales for rating dyspnea in young and older subjects. Respir Physiol Neurobiol, 2007. 157(2-3): p. 360-5.