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Research Article

Is There Any Simple Tool to Enhance Physical Activity in Patients With COPD?

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Abstract

Background: Physical inactivity is considered as a complex behaviour that predicts poor outcomes in COPD and hastens the disease progression. Pulmonary rehabilitation has been endorsed as an effective non-pharmacological therapy to enhance exercise capacity and quality of life in patients with COPD, yet its effects on promotion of physical activity is unknown. Furthermore, the recent international guidelines on pulmonary rehabilitation emphasize on "long-term health enhancing behaviour change" and increase in physical activity is considered to enhance positive health benefits in COPD. The current study had explored the effects of ground walking prescription combined with comprehensive pulmonary rehabilitation to promote physical activity in patients with COPD.

Methods: Retrospective analysis were performed on 33 COPD patients [FEV1: 59.08 % (± 22.00)] enrolled to a comprehensive 8 weeks out patients PR programme (PRP). Patients were provided with individualized ground walking prescription and feedback during PRP. Paired t-test was used to examine mean difference between outcomes at Week 0 and Week 8. A p - value < 0.05 was considered significant.

Results: 29 patients completed the 8 weeks out-patient PRP. Significant improvements were observed in 6 min walk test ($p < 0.0001$), incremental shuttle walk test ($p < 0.0081$), CAT score ($p < 0.0017$), Chronic Respiratory Disease Questionnaire total score ($p < 0.0002$) and mMRC dyspnea scale ($p < 0.0001$) at Week 8 compared to Week 0. Mean walking duration per session and days per week improved from Week 0 to Week 8 ($p < 0.0001$ and $p = 0.0054$).

Conclusion: This study suggests that inclusion of ground walking prescription would be pragmatic behavioral intervention during comprehensive PR to stimulate physical activity behavior in patients with COPD.

Keywords: *Chronic Obstructive Pulmonary Disease; Physical Activity; Behavioural Interventions; Exercise Training*

Introduction

Chronic obstructive pulmonary disease (COPD) is a multicomponent and progressive disease that not only affects the respiratory system but also has detrimental extra pulmonary effects such as skeletal muscle depletion and physical inactivity [1]. As a result, patients enter vicious circle of inactivity and symptoms, thereby adopting a sedentary lifestyle behaviour change that is difficult to reverse [2,3]. Recently, importance of physical activity in COPD has become a key focus based on many factors:

1. COPD is a public health challenge and perceived to be the third leading cause of death in the world [4,5].
2. Physical inactivity (refers to significant reduction in walking duration and intensity) is highly prominent in patients with mild to severe COPD compared with their age-matched healthy subjects or any people with other chronic disease such as

diabetes and arthritis [6-9]. These findings were consistent across settings, cultural background, geographic area and methods used to measure physical activity [10].

3. Physical inactivity is believed to potentially develop other co-morbidities including skeletal muscle dysfunction, right heart failure, secondary polycythemia, lung cancer, depression and anxiety, osteoporosis, altered nutrition and metabolic syndrome in the COPD population [11,12].

4. Physical inactivity independently predicts poor outcome, accelerates disease progression, systemic inflammation, frequency of hospital admission and mortality in the COPD population [13].

5. Recently, World Health Organization (WHO) has identified physical inactivity is featured in 1 of 4 adults, and physical inactivity being the 10th leading cause of death worldwide [14].

6. For the past three decades, there is a large body of evidence supporting the health benefits associated with participating at least 150 mins per week of moderate to vigorous physical activity (MVPA) in COPD population [15].

7. Yet the data reveals that the patients with COPD are not compliant with the recommendations for physical activity due to wide barriers including severity of disease, co-morbidities, exacerbation, behavioral, personal problems, socio-economic and demographic factors [16].

8. Pulmonary rehabilitation (PR) has clearly demonstrated a short-term (3 - 6 months) improvement in exercise capacity and quality of life, yet its effect on physical activity behaviour change is inconsistent across the literature to date [17].

9. A recent ATS-ERS update statement re-defined pulmonary rehabilitation (PR) as a "comprehensive multidisciplinary intervention to promote the long-term adherence to health-enhancing behaviors" [18]. This reiterates a need to focus the strategies from one promoting short-term exercise (refers PR to improve exercise capacity) to long term sustainable behaviour change (refers to change and adherence to simple physical activity such as walking).

Figure 1: *Schematic reflection on the need to consider physical activity as a key outcome of pulmonary rehabilitation for COPD.*

Reflecting on the above factors it is intuitively clear increasing physical activity (PA) might be a regarded as a patient centered therapeutic goal for both pharmacological and non-pharmacological interventions (Figure 1). Hence, the promotion of PA is considered crucial by the recent ATS-ERS statement on pulmonary rehabilitation outcome of pulmonary rehabilitation for COPD population [18].

With the increasing awareness on physical activity and invention of new technology, there is a search for pertinent patient reported outcome tool (PRO active PRO instruments) to measure and prescribe the daily PA [19]. As poor walking endurance being a common problem and barrier for PA verbalized by patients with COPD, walking training (either ground or treadmill) might be considered as a

feasible tool to improve PA [20]. In addition, it is documented that external factors such as effort spent, motivation, instructions and encouragement interprets difference in improvement of daily physical activity (ground walking) compared to 6-minute walk test [21]. Moreover, based on existing evidence, it is reasonable to use a hybrid tool (refers to a combination of exercise training couple with behavioural change approach) to increase daily PA in COPD population. Thus, this study had explored the immediate effects of providing a ground walking prescription in a comprehensive pulmonary rehabilitation on physical activity in patients with moderate to severe COPD.

Objective of the Study

The current study explored whether providing a ground based walking prescription during a comprehensive pulmonary rehabilitation (PR) enhances physical activity behaviour in patients with moderate to severe COPD.

Methods and Measurements

Participants and Study Design

Data was extracted from the records of 33 patients who were enrolled to the 8 weeks comprehensive outpatient pulmonary rehabilitation programme (PRP) between January to May 2014 in a small renowned hospital in Ireland. The inclusion criteria were a) A primary diagnosis of COPD according to GOLD criteria [1]; b) Completion of at least 18 sessions out of 24 sessions in 8 weeks of PRP was deemed appropriate for graduation from PRP; and c) Completion of post-rehab assessment. This analysis included patients with exacerbation prior to and/or during the 8 weeks PRP. As a part of routine practice, a written consent for participation and compliance to PR was obtained from patients. Ethical approval was not indicated as the entire intervention was done as a part of the routine PRP and analyzed retrospectively. The local Board of Director for pulmonary rehabilitation approved the use of de-identified patient records.

Intervention

Pulmonary Rehabilitation program (PRP) at our hospital was a standard programme involving exercise training and education (Appendix C). A key emphasis was placed on physical activity behaviour change through ground-based walking prescription during PRP.

8 weeks supervised Exercise training/30mins per session/3 session per week									
	Week 1-2			**Week 3-5**			**Week 6-8**		
Stationary Bike (Interval training)	**Intensity**	**Duration**		**Intensity**	**Duration**		**Intensity**	**Duration**	
	Borg 3-4	**5 mins**		**Borg 4-5**	**5-10 mins**		**Borg 4-5**	**10 mins**	
Aerobic Stopper (Endurance training)	**Sets**	**Reps**	**Intensity**	**Sets**	**Reps**	**Intensity**	**Sets**	**Reps**	**Intensity**
	1	**25**	**Borg 3-4**	**2**	**50**	**Borg 4-5**	**3**	**75**	**Borg 4-5**
Strength Training (80% of 1 RM)	**Sets**	**Reps**	**Intensity**	**Sets**	**Reps**	**Intensity**	**Sets**	**Reps**	**Intensity**
	1	**12-15**	**Borg 2-3**	**2**	**12-15**	**Borg 3-4**	**3**	**12-15**	**Borg 3-4**
Warm-up- 5 mins				**Cool-down- 8 mins**					

Appendix C

Walking Prescription

As part of the comprehensive PRP, ground based walking duration was prescribed at Week 0 as described in Box 1. Patient's baseline 6MWT was used to prescribe the duration and modified Borg dyspnea scale was used to prescribe the intensity of ground-based walking.

For the ground based walking prescription (Figure 2,3), 80 % of the duration required to achieve twice the baseline 6 MWD was prescribed as baseline target duration. The target duration was split between 6 levels at varying intensity (3 - 5) using modified Borg dyspnea Scale (Appendix A). Patients were instructed to complete 2 sessions per day, at least 4 - 5 days per week of ground based walking prescription and record in the log sheet (Appendix B). Patients were advised to commence ground walking prescription on the Day 1 of 8 weeks PRP and get the log sheet checked by the physiotherapist during their attendance for supervised exercise training (3 sessions per week) in pulmonary rehabilitation department.

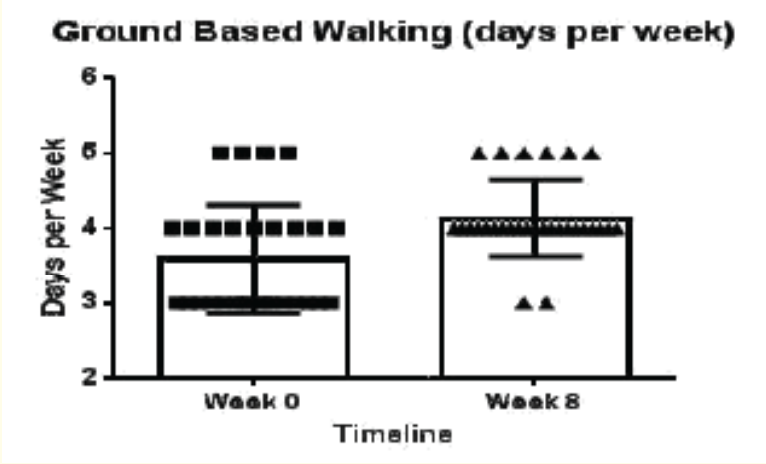


Figure 2: *Ground based walking (days per week).*

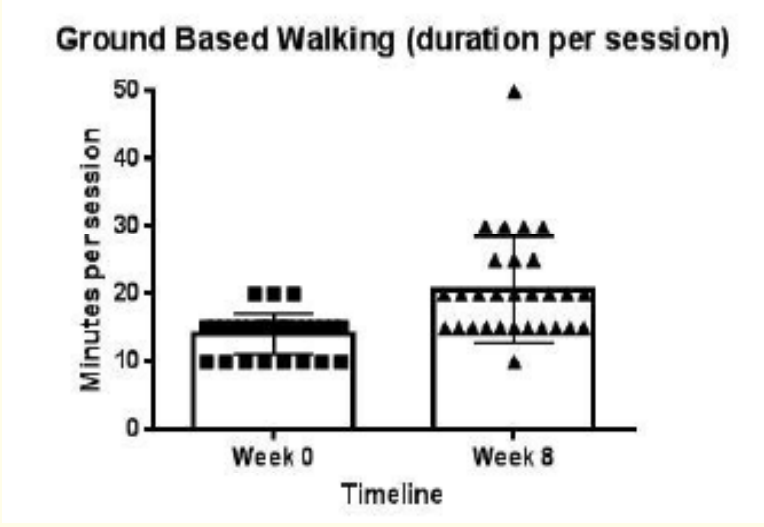
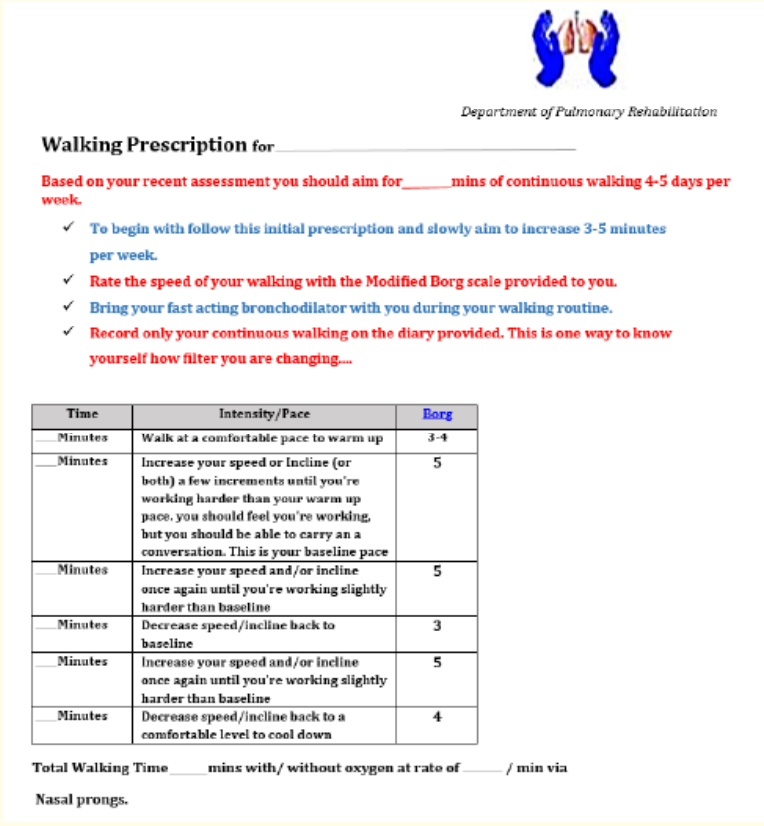


Figure 3: *Ground based walking (duration per session).*



Department of Pulmonary Rehabilitation

Walking Prescription for_____

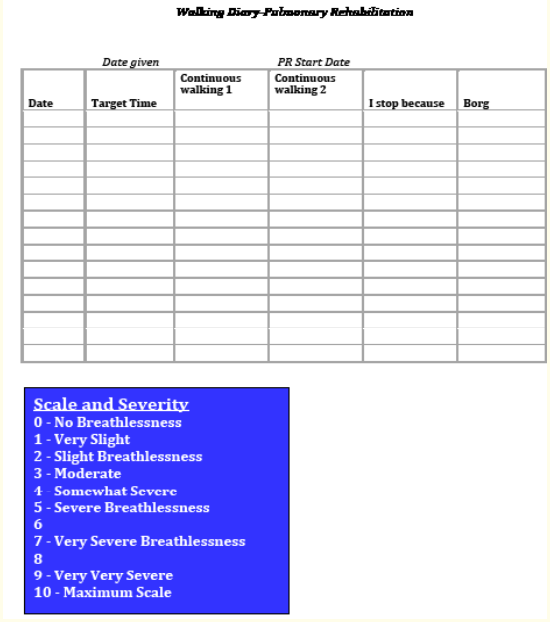
Based on your recent assessment you should aim for_____mins of continuous walking 4-5 days per week.

- ✓ **To begin with follow this initial prescription and slowly aim to increase 3-5 minutes per week.**
- ✓ **Rate the speed of your walking with the Modified Borg scale provided to you.**
- ✓ **Bring your fast acting bronchodilator with you during your walking routine.**
- ✓ **Record only your continuous walking on the diary provided. This is one way to know yourself how filter you are changing....**

Time	Intensity/Pace	Borg
___Minutes	Walk at a comfortable pace to warm up	3-4
___Minutes	Increase your speed or Incline (or both) a few increments until you're working harder than your warm up pace, you should feel you're working, but you should be able to carry an a conversation. This is your baseline pace	5
___Minutes	Increase your speed and/or incline once again until you're working slightly harder than baseline	5
___Minutes	Decrease speed/incline back to baseline	3
___Minutes	Increase your speed and/or incline once again until you're working slightly harder than baseline	5
___Minutes	Decrease speed/incline back to a comfortable level to cool down	4

Total Walking Time_____mins with/ without oxygen at rate of_____/ min via Nasal prongs.

Appendix A



Walking Diary-Pulmonary Rehabilitation

Date given *PR Start Date*

Date	Target Time	Continuous walking 1	Continuous walking 2	I stop because	Borg

Scale and Severity
0 - No Breathlessness
1 - Very Slight
2 - Slight Breathlessness
3 - Moderate
4 Somewhat Severe
5 - Severe Breathlessness
6
7 - Very Severe Breathlessness
8
9 - Very Very Severe
10 - Maximum Scale

Appendix B

Walking Prescription = Time required to complete 80% (2 × 6 min walking distance)/ 2 sessions per day/ at least 4-5 days per week.

For example: Patient A, 70 yrs old, COPD GOLD stage 2, Ex-smoker 2yrs and 3 chest infections per year referred for PR. On 6MWT, he is able to walk a distance of 400 m with maximum Borg of 5.

- **Walking prescription for Patient A = 80%(2* 400) = 640m**
- **Patient A would reach 640 m in 9.6 mins (approximately 10 mins)**
- **Therefore, the initial prescription would be 2 sessions of 10 mins continuous walk each at varying intensity (BORG SCALE) for 4-5 days per week and increase by 3 mins each week for subsequent 7 weeks to achieve a target of continuous 31 mins per day, 4-5 days per week by end of week 8.**

Box 1: *Walking Prescription.*

During baseline assessment, one session of individualized ground based walking training was provided to patients. In the training, patients were instructed on to how to perceive and record the intensity and duration of walking on the log sheet attached to the walking prescription. During the training, rest breaks were permitted in the event of intolerable symptoms such as dyspnea, wheeze, leg pain, fatigue, palpitations or dizziness and were instructed to record only the minutes completed prior to the break.

In the event of breaks, patients were advised to recommence new walking session as soon as they felt able or later in the same day and not to count their rest breaks in their prescribed duration. Patients log sheet was supervised weekly by the physiotherapist and possible feedback on progression of ground walking duration was provided during the 8 weeks PRP.

Progression of walking duration was individualized by an increase of 3 or 4 minutes each week, based on patient's ability to complete their initial prescription. Compliance to the walking prescription was deemed by completion of at least 64 walking sessions on log sheet by end of 8 weeks PRP (at least 4 days per week). In the event of exacerbation or illness, patients were allowed to extend their PR and walking session by a maximum of 2 weeks.

Clinical Measurements

As part of routine assessment, pulmonary function testing (Pneumotac ACH, Jaeger, Germany) was performed in accordance with standard protocols (Miller., *et al.* 2005) and disease severity of each patient was graded according to GOLD spirometry criteria [1].

Patient's functional and peak exercise capacity was measured using 6 min walk test (6MWT) and incremental shuttle walk test (ISWT) respectively. Two 6 min walk test (6 MWT) and incremental shuttle walk test (ISWT) were performed over two visit within a 7-day period according to standard protocols and test with longest distance considered for further analysis. Except for 6MWT a 10m track was used instead of 30m due to lack of space. During all walk tests, patient's dyspnea (modified Borg scale 0 -10) and oxygen saturation SpO2 and heart rate (Huntleigh Healthcare, smart signs Mini Pulse) were continuously monitored. During the walk tests, if SpO2 falls below 80%, the ISWT was terminated and a rest was imposed on 6 MWT until SpO2 rise to > 90%. Patient's quality of life was measured using two questionnaires; COPD assessment test (CAT) score and short-form Chronic Respiratory Disease Questionnaire (SF-CRDQ). CAT is a simple eight item tool used to assess the health status in patients with COPD. The SF-CRDQ has 8 questions that examine four domains: dyspnea (2 questions), fatigue (2 questions), emotional function (2 questions) and mastery (2 questions). Each question is scored from one to seven with higher scores reflecting less impairment in health status. Patient's self-reported disability from breathlessness was measured using Modified Medical Research Council (MMRC) dyspnea scale.

Data Analysis

Statistical analysis was performed with statistic software (Prism3, Graph Pad Software,) only on the data of completers of 8 week PRP. Paired t- test was used to compare the mean difference between outcomes measures at baseline and post PR. A value of $P < 0.05$ was considered significant.

In 6MWT, minimal clinical important difference (MCID) of 25m was considered significant, whereas in ISWT, a difference of 45m (slightly better) or 75m (better) was considered significant post intervention [22,23]. A MCID) of -2 points and + 4 for CAT-score and total score SF-CRDQ respectively was considered significant post intervention [24,25]. Based on ACSM current recommendations of PA for COPD population [26], two sessions of ground based walking (PA) per day, each session of atleast 15 mins, 3 days per week was considered to be significant improvement in daily PA behaviour in this study.

Results

The flowchart of study design is presented in figure 4. Twenty-nine (87.8%) out of 33 patients completed the post rehab assessment (mean ± SD FEV1 59 ± 22 % predicted, age 71 ± 7). Baseline characteristics of patients are represented in Table 1. Four patients dropped out at Week 3 of PRP for the following reasons: withdrew due to medical conditions other than COPD (n = 3); unable to continue PRP due to severe exacerbation of COPD (n = 1). The mean attendance to 8 weeks PR was 23 sessions [1] and no adverse events reported. Patients completed 80 % of walking session (64 sessions out of 80 sessions), atleast 4 days per week. 20 patients recorded dyspnea and fatigue as reasons for their rest breaks during walking. No adverse events reported during walking.

Variables	No/ Mean(SD)
Patients	29
Age (yrs)	71(7.0)
Gender (M/F)	10/19
Current smokers	3
Exacerbation per year	4
FEV1(% predicted)	59(22)
FVC (% predicted)	97(18)
FEV1/FVC (% predicted)	47(13)
Duration of ground based walking per week (mins)	14(3)
Frequency of ground based walking per week (days)	2(1)
Patients on ambulatory oxygen	7

Table 1: *Baseline characteristics of patients in the study.*

Data are presented as n, mean (SD) or n (%); FEV1: forced expiratory volume in 1s; FVC: forced vital capacity

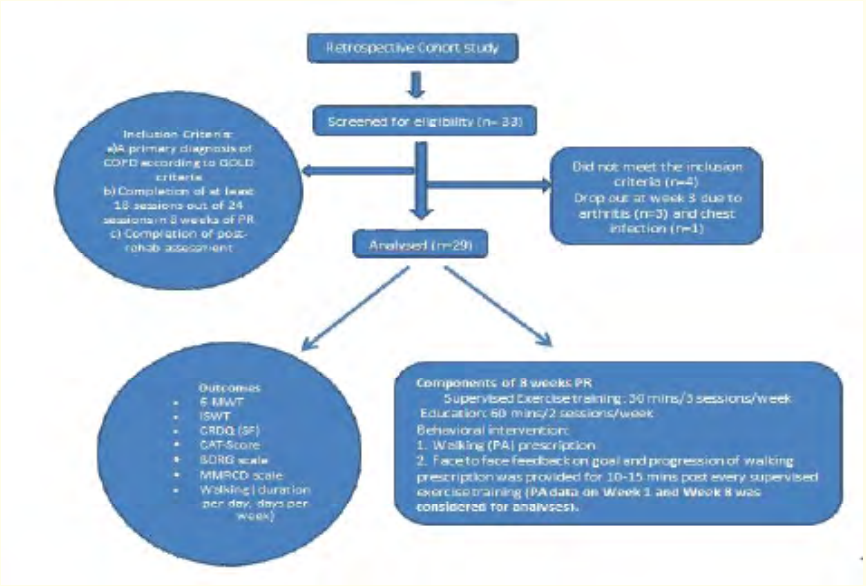


Figure 4: *Study Design.*

Effect of Intervention

Pre (Week 0) and Post (Week 8) intervention data for all outcomes are presented in Table 2. A significant mean difference was noted in both functional and peak exercise capacity measured by 6 MWT and ISWT respectively at Week 8 (Figure 5). Additionally, a significant difference was noted in CAT score and CRDQ total score compared to baseline (Figure 6). Furthermore, patient disability from breathlessness measured by MMRC dyspnea demonstrated a significant difference ($P < 0.0001$) compared to baseline (Figure 7).

Parameters	Pre-Rehab [Mean(SD)]	Post-Rehab [Mean(SD)]	Mean difference	P value
6MWT (meters)	385.5 (65.2)	472.1 (73.9)	87	< 0.0001
ISWT (meters)	335.5 (146.0)	399.7 (134.8)	64	0.0081
PA (mins)	14.1(3.0)	20.69 (7.9)	7	< 0.0001
PA (days per week)	3.5 (0.7)	4.1(0.5)	1	0.0054
CAT-Score (points)	23.6(6.1)	18.90 (7.9)	5	0.0017
CRDQ (points)	13.0(3.6)	17.70 (2.7)	5	0.0002
Borg (points)	5 (1.2)	4 (0.9)	1	0.0073
MRCD (points)	4 (0.6)	3 (0.6)	1	< 0.0001

Table 2: *Pre and Post Rehab Results.*

Patient's demonstrated a positive change in PA behaviour with an increase in ground based walking duration ($p < 0.0001$) of 20 mins per day (no rest breaks) for 4 days per week at Week 8 compared to Week 0. Patient's also maintained their intensity of ground based walking between 5 (very severe breathlessness) to 4 (somewhat severe) on modified Borg scale (Figure 8).

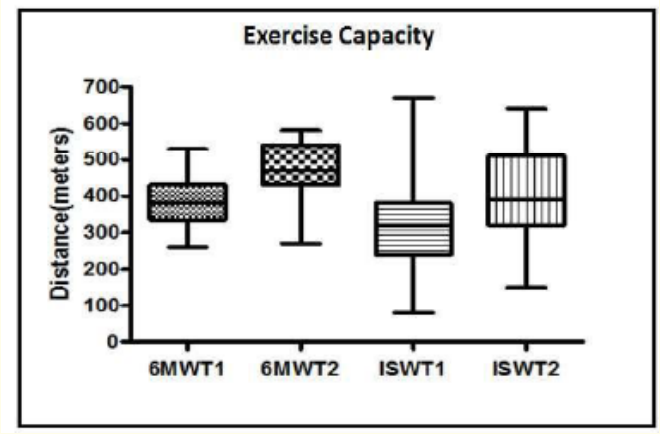


Figure 5: *Exercise Capacity (6MWT 1 & ISWT 1 measured at Week 0; 6MWT 2 & ISWT 2 measured at Week 8).*

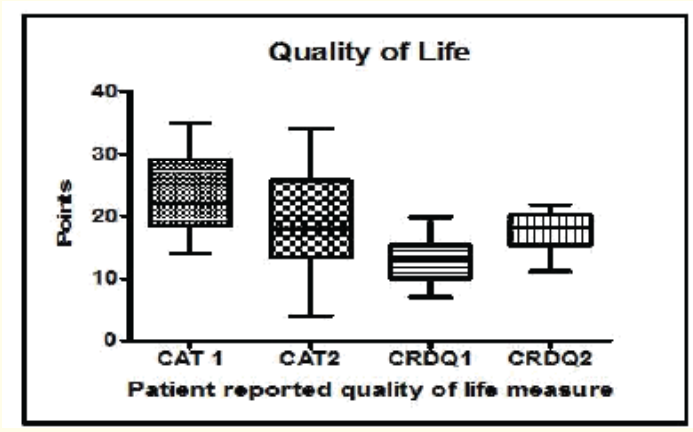


Figure 6: *Quality of life (CAT 1& CRDQ1 measured at Week 0; CAT 2 & CRDQ 2 measured at Week 8).*

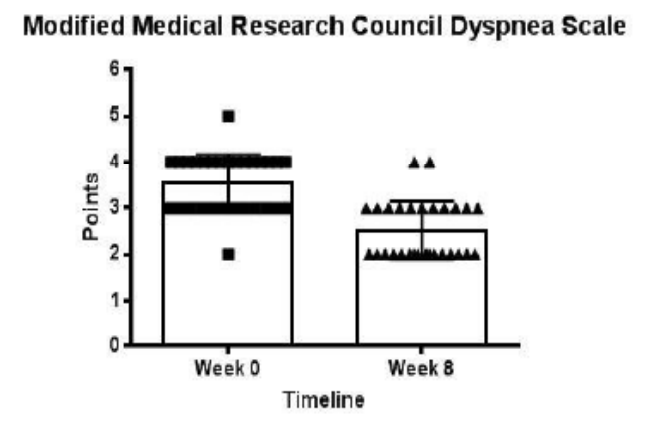


Figure 7: *Modified Medical Research Council Dyspnea Scale.*

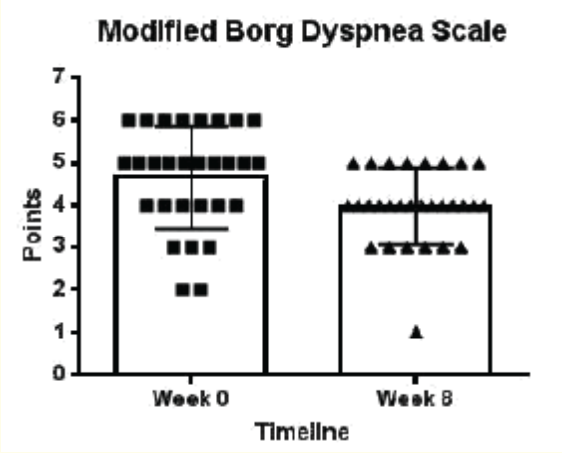


Figure 8: *Modified Borg Dyspnea Scale.*

Discussion

This study demonstrated that inclusion of a ground walking prescription during a comprehensive pulmonary rehabilitation (PR) is a feasible component to witness immediate improvement in physical activity (PA) behaviour in patients with moderate to severe COPD. Moreover, the results of ground walking (duration per session and days per week) obtained at Week 8 inevitably argue adherence to PA was satisfactory. Yet, there are still some issues that need to be addressed to enhance long-term PA behaviour change in COPD population.

To my knowledge, this is the first study in Ireland to evaluate the effects of a ground walking prescription in a comprehensive pulmonary rehabilitation setting. This study also justifies the recent findings of a large randomised study [27] promoting ground based walking as a cheap, easy and a meaningful tool to improve exercise capacity, physical activity and quality of life for patients with COPD.

Our patients demonstrated a significant mean improvement in the ground walking duration [mean difference of 6 mins (360 seconds)] per day compared to baseline, confirming a positive change in physical activity behaviour. We confirm this improvement in walking duration (360s) was significant compared to previous two studies (279s and 186s) achieved [20,27]. Additionally, our patients were able to complete 2 sessions of 20 mins (40 mins) per day, at least 4 days per week. The high compliance to session and duration on ground walking prescription could be attributed to individualised supervision by an experienced physiotherapist to ensure appropriate progression of duration and intensity of walking.

A notable finding was that our patients attained 37.5m in exercise capacity by exceeding the minimal important clinical difference in 6MWT [22], despite compromise in track length (difference between 10m and 30m) with a mean difference of 49.5m. Similarly, our patients attained a significant difference of 64m in incremental shuttle walking test, exceeding the minimal difference [23] reaffirming patient's exercise capacity was 'slightly better' following pulmonary rehabilitation. Additionally, a clinically significant difference was noted in health-related quality of life measures including CAT score (-5 points) and total score of SF-CRDQ (5 points) [24,25]. Interestingly, the improvements noted in exercise capacity and health related quality of life were significant compared to previous study [27]. It is likely that the observed improvements in exercise capacity, quality of life and ground based walking (duration and days) could be related to the education on physical activity and self-efficacy during supervised PR sessions that might have ameliorated their fear of increasing PA with dyspnoea. However, future studies are warranted to isolate the effect of PA education during PR.

Overall, our patient's compliance to both ground walking prescription and PRP was satisfactory. Of note, our patients (40 mins per day, 4 days per week) exceeded the minimal PA recommendations for COPD by American college of sports medicine [26]. Patients felt that the individualized goal setting on PA, supervision by health professional (physiotherapist) weekly and feedback on progression of PA had

improved their motivation and adherence to daily PA behaviour.

Major limitation of this study was small sample size and lack of control group which may have contributed to insufficient power in comparisons of some outcome measures. The lack of control group may have acted as a confounding factor that might have hindered to determine the absolute effects of ground based walking prescription. Future prospective randomized trials are needed to investigate the effect of ground based walking prescription in patients with COPD during PR of varying programme duration (6 weeks to 24 weeks). In addition, the ground based walking data was subjective (recorded by patient on log sheet) and data was collected only from Week 0 and Week 8 of PRP. This was deemed appropriate due to constraints on physiotherapist time and funding for resources. As a result, it was not possible to determine if there was any earlier improvement in PA behaviour before Week 8.

A further limitation of this study was that the results cannot be generalized to COPD population as this training was performed only on moderate to severe COPD patients. Moreover, this study only focused on short- term (8 weeks) PA behaviour change and did not include any objective measurements; therefore, future epidemiological or randomised trial is warranted to appreciate the long-term benefits of ground based walking prescription compared to objective PA tools during a comprehensive PRP.

Despite the limitations, this study had a low drop-out rate of 12 % in contrast to high drop-out of 20 - 30 % in any pulmonary rehabilitation programme [28]. This could be attributed to shorter duration (30 minutes) of structured exercise, individualized simple PA prescription (walking), feedback on progression of PA and increased frequency of contact with patients might have empowered patient's adherence to both PRP and PA. Moreover, patients had verbalized that the word "Walking Prescription" possibly had a positive behavioral effect on their compliance to physical activity (ground-based walking). As documented in literature, our walking prescription might be debated as a simple behavioural interventional tool providing feedback on intensity and duration of PA (behavioural approach) that can used in any pulmonary rehabilitation setting to improve daily PA in COPD population [29,30].

Moreover, there is no cost associated with the ground based walking prescription and only feedback (10 -15 mins). Furthermore, due to increase in COPD death toll, disparity in access, funding and barriers to adherence to formal PR worldwide, it is reasonable to believe that ground based walking prescription is a cost-effective, pragmatic tool to enhance daily PA and could be implemented in various health-care settings [31-36]. However, future well designed studies are warranted to support the findings in this study.

Conclusion

In conclusion, this study supports the robust idea of incorporating a ground based walking prescription during a comprehensive pulmonary rehabilitation to enhance PA behaviour change in patients with moderate to severe COPD. Thus, this new robust exercise regimen facilitates the goal of PA behaviour change and optimizes the effects of pulmonary rehabilitation to meet the growing demands of COPD worldwide.

Competing Interest

The author have no competing interest to declare.

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