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ORIGINAL ARTICLE

Pulmonary rehabilitation in chronic obstructive pulmonary disease: Outcomes in a 12 week programme

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Abstract

Objective. The optimal time-frame for pulmonary rehabilitation (PR) in patients diagnosed with chronic obstructive pulmonary disease (COPD) is still debated. A 12 week programme was designed looking at whether the benefits were reached at or before a 12 week period of PR for COPD patients. *Method*. Seventy-five patients (59 males, 16 females) aged 40–75 years were referred from the local general hospital in Malta. Baseline assessments were carried out on all patients 2 weeks before initiation of the programme. Sixty patients were eligible to start a twice-weekly, 12 week multidisciplinary programme delivered after the screening process. The Six-Minute Walk Test (6MWT), dyspnoea score using the Borg scale, spirometry testing, plethysmography, COPD Assessment Tool (CAT) score, St George's Respiratory Questionnaire (SGRQ) and Hospital and Anxiety scale score were monitored at 4 weekly intervals throughout the 12 weeks of PR for these COPD patients. *Results*. The 6MWT distance increased by a mean total of 132.45 m ($p < 0.001$) by 12 weeks, with the highest change recorded in the first 4 weeks for the milder COPD patients. Lung function test improvements were marginal. Borg scale readings at rest and following exertion decreased significantly from weeks 0 to 4 but remained fairly constant thereafter. The Body mass index, airway Obstruction, Dyspnoea, and Exercise capacity (BODE) index, SGRQ and CAT score values decreased significantly throughout the weeks irrespective of the initial Medical Research Council score. Anxiety scoring decreased significantly by 12 weeks, while the depression rating improved by 8 weeks. *Conclusion*. These findings show that 12 weeks of PR in this cohort of COPD patients resulted in clinically significant changes in functional outcome measures which are supported by statistically significant changes in health-related quality of life measures. In milder COPD cases, by 4 weeks of PR gains in exercise tolerance had already resulted. The more severe group required more time to obtain improvements. Therefore, hospitals could organize shorter PR programmes for larger numbers of patients with milder COPD.

Key words: *Anxiety, depression, duration, exercise tolerance, health-related quality of life*

Introduction

This article reports a study investigating outcomes in a 12 week pulmonary rehabilitation (PR) programme for patients with chronic obstructive pulmonary disease (COPD). COPD is a major health concern. By the year 2020, it is estimated that COPD will be the third leading cause of death and fifth leading cause of chronic disability worldwide (1). Patients who suffer from this condition make use of health services on a regular basis, partly because of a lack of understanding of their condition and partly due to their inability to cope with frightening and disabling symptoms (2,3). PR has been recommended as a key intervention for people with COPD (4).

Significant gains in exercise tolerance (5–7), dyspnoea measures (5) and improvements in quality of life (8) have been observed following outpatient PR programmes. One of the debated issues on improvements in these outcome measures arises from the huge variations in the time-frames for this type of intervention across Europe and the rest of the world (4,9–11). These programmes range from a duration of just 4 weeks (12,13) up to 18 months (14,15). Shorter programme durations have been documented

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to have the probability of reducing the cost of treatment per patient and to expand limited resources (16). On the other hand, longer duration programmes produce greater gains and improve the maintenance of benefits (12,14,15,17). The British Thoracic Society guidelines for PR suggest programmes of a minimum of 6 weeks and a maximum of 12 weeks (4).

Studies by Berry et al. (14), Foy et al. (15), Troosters et al. (17) and Guell et al. (18) looked into interventions ranging from 3 to 18 months of exercise training (14,15), to PR over a 6 month timeframe (17). Guell et al. (18) looked at a 12 month intervention divided into 6 months of daily rehabilitation followed by 6 months of weekly supervision. All the studies reported improvements in exercise tolerance, as well as a reduction in self-reported disability. No comparison of outcomes in a shorter time-frame was carried out, giving little indication of when the improvements happened. Improvements were reported in the first 3 months, a period when the subjects where receiving breathing retraining only. The reasons for this improvement are not clear.

In a 26 week intervention, Baumann et al. (19) reported significant differences for most outcome measures [Six-Minute Walk Test (6MWT), maximum workload and health-related quality of life scores]. These results compare well to those of Guell et al. (18) and Troosters et al. (17), but Baumann's intervention comprised a low-intensity weekly training programme, in contrast to other studies which used high-intensity training programmes.

Shorter programmes also reported significant changes in outcomes. Verrill et al. (20) and Green et al. (12) showed that patients had significant gains in exercise tolerance, dyspnoea scores and health status after 12 weeks of PR. In the case of Verrill et al. (20), an additional 12 weeks of rehabilitation resulted in improvements in exercise tolerance but not in health status or dyspnoea outcomes. This suggests that the programme duration may not have an equal impact on all of the outcome measures. Green et al. (12) reported improvements in a 7 week programme as opposed to a 4 week intervention. However, the latter group of participants were not reassessed again at the 7 week time-point, not allowing one to determine whether the results obtained at 7 weeks were caused by some delaying effect. The study by Green et al. (12) was readdressed by Sewell et al. (13) in 2006, who studied 100 patients with moderate to severe COPD. This time, patients who were in the 4 week training group were also examined at 7 weeks. All patients reported significant improvements in exercise tolerance and health status. Participants in the 4 week programme had gains in exercise tolerance at both the 7 week and 6 month follow-up periods that were comparable to those following the longer 7 week programme. One can postulate that reassessment at the 7 week time-point could have had a positive effect on compliance with unsupervised exercise sessions at home. Andrews et al. (21) looked at 363 COPD patients undergoing PR at three different time-points (6, 7 and 8 weeks). All groups included patients with a Medical Research Council (MRC) score of 3 or above. This study indicated a statistically significant improvement in the exercise capacity of all the participants in the three programmes. Those who underwent an 8 week programme improved the most, with a 6MWT distance of 80 m, followed by those in the 6 week and then the 7 week programme (62 m and 52 m, respectively). Participants enrolled in the 8 week programme reported better outcomes in the clinical COPD questionnaire, whereas those who underwent a 6 week programme had significant improvement on the St George's Respiratory Questionnaire (SGRQ). Andrews et al. (21) stated that participants with a low health-related quality of life before PR may improve more than those with higher baseline levels, or that the programme offered to these patients may have been relatively short. This study included a mix of COPD and patients with other respiratory conditions. Apart from that, although patients with different clinical severity of disease were included, no analysis of how patients faired with regard to clinical symptoms through the course of rehabilitation was provided.

Despite the vast amount of literature available on PR in COPD (2–4,14,15,17,18,22,23), no consensus of opinion regarding the optimal time-frame has yet been established (11). In the present study, we explore the benefits obtained through a 12 week PR programme. The potential benefits gained at various time-points throughout this intervention, at weeks 4, 8 and 12, in people diagnosed with various severities of stable COPD were investigated.

The British Thoracic Society guidelines (4) give significant importance to the severity aspects of COPD patients participating in PR programmes. The need for flexible approaches to facilitate patients of all severities to help them to complete their rehabilitation is highlighted. Conflicting results are still found when it comes to including COPD patients in PR programmes with different MRC scores. Bolton et al. (4) noted that COPD patients with an MRC score of 2 benefit from PR with an evidence level of 3 and those with an MRC score of 5 would benefit just as well. More studies looking into the gains of COPD patients according to the staging of their disease is still required, allowing for more specific modes of training depending on the needs of these individuals.

Method

This article reports a longitudinal, observational type of study. Data obtained from this study were recorded at baseline, after 4 weeks (eight sessions), after 8 weeks (12 sessions) and after 12 weeks (24 sessions) of PR. Participants were then followed up at weeks 28 and 52 on completion of the PR programme, although the last two periods are beyond the scope of this paper. Comparisons have been made among times, with each patient serving as his or her own control.

Participants

Seventy-five patients (59 males, 16 females) with a confirmed diagnosis of COPD were referred from the medical wards and respiratory outpatient clinic of the local general hospital in Malta. The definition of COPD adopted for this study was that provided by American Thoracic Society/European Respiratory Society guidelines (24). Patients had a self-reported smoking history, clinical signs and symptoms, together with spirometry readings that were consistent with COPD and exertional dyspnoea (MRC grade 2 or above). These participants were all found to be medically stable by the respiratory physicians and pharmacological treatment was assured to be optimal. This remained consistent throughout the PR programme. Eight participants did not meet the inclusion criteria [unstable ischaemic heart disease ($n = 2$), diagnosis of lung cancer ($n = 1$), presence of mobility problems affecting participation ($n = 3$) and lack of transport ($n = 2$)]. Another seven patients did not accept to participate in the PR programme for various personal reasons.

Sixty patients agreed to participate in this study after having been assessed by medical doctors and a physiotherapist. The inclusion criteria were oxygen saturations of $>92\%$ at rest, willingness to participate in the rehabilitation classes, stable cardiovascular system and no neurological or orthopaedic problems which could interfere with rehabilitation. Each participant was provided with written information about the programme and invited to join in this study. Those who did not meet the criteria were given an appointment for respiratory physiotherapy within the hospital department. Consenting participants were enrolled into a 12 week PR programme. However, participants who required modifications to their drug therapy owing to exacerbations were excluded from the study.

Measurements

Patients were assessed 2 weeks before enrolling on the programme and then at 4 weekly intervals throughout the intervention. The following outcomes were measured: spirometry, 6MWT, Borg scale, SGRQ, Body mass index, airway Obstruction, Dyspnoea, and Exercise capacity (BODE) index, Hospital and Anxiety (HAD) scale score and COPD Assessment Tool (CAT) score. Each participant was classified according to the MRC dyspnoea scale, placing them into one of five categories, i.e. 1 to 5, according to self-perceived breathlessness during daily activities (25).

To complement the MRC scale, the BODE index was also measured. This index measures disease severity based on the body mass index, degree of airway obstruction measured by forced expiratory volume in one second (FEV_1), dyspnoea assessed by the MRC scale and exercise capacity measured by the 6MWT. Each component is given an index, with the total score ranging from 0 to 10 points. Higher scores indicate greater severity (26).

Exercise tolerance rating. The 6MWT was performed according to American Thoracic Society guidelines (27). Each patient was instructed to walk as rapidly as possible in a 30 m corridor for 6 min. The test was repeated twice with an interval of 30 min. The longest distance on a 6MWT and oxygen saturation were utilized to measure exercise capacity. Dyspnoea was scored using the Borg Category Ratio scale (28) to measure symptoms during exercise before and after the test.

St George's Respiratory Questionnaire. The SGRQ is a widely used questionnaire owing to its specificity to respiratory diseases. This questionnaire consists of 50 items, separated into three parts: symptoms (distress due to respiratory symptoms), activities (effects due to impairment of mobility or physical activity) and effects (psychosocial effects of the disease). The scores range from 0 to 100 for the three subscales, with a summary total score. Higher scores indicate worse health status; 0 indicates no impairment and 100 indicates maximal impairment (29). The SGRQ has been shown to have an adequate interrater reliability and reproducibility as well as the ability to quantify change over time (29).

COPD Assessment Tool. The CAT tool looks into symptoms, presenting two statements for each symptom which describe the best (score of 0) and worst (score of 5) self-assessment for that statement (29,30). The scores for each of the eight items are then added up, giving one final score (with a minimum of 0 and maximum score of 40) (31,32). The higher the value of this score, the worse the health status of the individual. This score has a high internal consistency (Cronbach's $\alpha 5$ 0.88) as well as reproducibility (intraclass correlation coefficient = 0.80).

Hospital Anxiety and Depression score. The HAD scale has been specifically developed for the recognition of anxiety and depression in patients with somatic conditions. It is a validated tool which looks into the symptom severity in patients with chronic diseases who have anxiety and depressive related signs (33,34). The HAD scale is divided into an anxiety (HADS-A) and a depression subscale (HADS-D), each of which contains seven items rated 0–3, with the highest possible score for each domain being 21. Scores less than 8 indicate no clinical distress, scores between 8 and 10 indicate possible psychiatric morbidity, and scores of 11 or more indicate pathological levels of distress (34). The HAD score has been widely used and translated in several countries and has demonstrated reliability and validity when used to assess medical patients (34).

Intervention

A multidisciplinary PR programme was delivered twice weekly for 12 weeks. Each class was of 2 h duration, with the first hour consisting of exercises made up of 5 min warm-up, walking on a treadmill, the speed of which was devised from the 6MWT and the time gradually increased throughout the weeks; step-climbing, arm ergometry, cycling using a stationary bike, and strength training for the upper and lower limbs using weights. Inspiratory muscle training was carried out using the Respironics IMT Threshold trainer® for 15 min during the class. All participants were asked to carry this out at home for 30 min of training 5 days per week over and above the additional general exercise recommended below. The following educational sessions covered various aspects of COPD care and self-management by medical doctors, psychologists, physiotherapists, dieticians and respiratory nurses. Patients also received an individualized home exercise programme consisting of exercise similar to what was being carried out during the classes. Each participant was encouraged to perform at least 20 min of these exercises per day. These sessions were monitored by a home diary system provided to each participant at the start of the programme.

Ethical considerations

Informed consent was requested and the possibility to quit the programme was allowed if the participants so desired. All data collected about the participants were coded to ensure patient confidentiality, with the information collected being used only for the purposes of the study. Ethical approval was obtained from the University of Malta Research Ethics Committee.

Statistical analysis

Statistical analysis was carried out using Statistical Package for Social Science (SPSS) software, version 22. Baseline characteristics and exercise data are presented as mean ± SD. Differences in the outcome measures were compared using repeated measures analysis of variance, and where analysis of variance identified a significant difference, *post hoc* tests were computed. The mean difference and 95% confidence interval (CI) are presented where necessary. A p value < 0.05 was considered statistically significant.

Results

Out of the 60 patients recruited for this study, 49 patients completed the full programme (43 males, six females). Three participants stopped after 4 weeks as they were finding no benefit in participation and two had to suspend their rehabilitation after 8 weeks for personal reasons. Their mean age was 66 ± 7.76 years, weight 75 ± 14.97 kg and height 164 ± 7.54 cm. Thirty-one per cent ($n = 15$) of the subjects were classified with an MRC score of 2, 29% an MRC of 3 ($n = 14$), and 20% ($n = 10$) each with an MRC of 4 and 5. It was only for statistical purposes that the patients were divided into MRC groups as mild to moderate (MRC 2–3) and severe and very severe (MRC 4–5).

Comparing results before and after the rehabilitation phase, no significant effects on any of the pulmonary function tests were noted. However, significant improvements were obtained in exercise tolerance and quality of life measures.

Six-Minute Walk Test

Significant improvements in the 6MWT distance were recorded for all the cohort of patients taken together after 12 weeks of rehabilitation, with a total change of 138.91 m ($p < 0.001$). Through *post hoc* analysis using Bonferroni corrections, the most significant changes in the whole group were registered in the first 4 weeks (mean total increase of 68.54 ± 91.62 m; $p < 0.001$). Patients with a mild to moderate severity (MRC 2–3) registered a significant increase of 126.96 m (32%; $p < 0.001$), with most of the improvement happening during the first 4 weeks of rehabilitation (61.43 ± 78.34 m difference; $p < 0.001$). Subjects in the severe to very severe category (MRC 4–5) registered a lower percentage improvement, but still had a significant change after 12 weeks of rehabilitation, with an increase of 164.61 m (58%) in distance ($p = 0.007$). *Post hoc* analysis of this group registered no significant changes at the 4 and 8 week time-points compared to baseline (Figure 1).

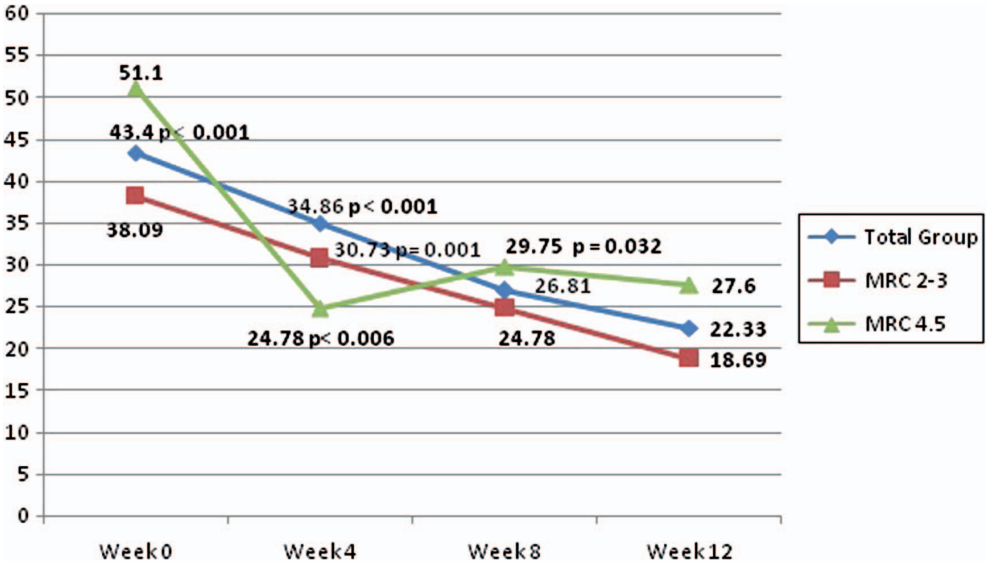

Figure 1. Graph showing the changes in the Six-Minute Walk Test for the whole group and the subgroups with Medical Research Council (MRC) score 2-3 and MRC 4-5. Time-points that registered a statistically significant change have been noted.

The changes in exercise tolerance also resulted in significant decreases in the dyspnoea ratings following the exercise tolerance test, from 3.49 ± 1.93 to 1.90 ± 1.56 ($p < 0.001$). This drop was most marked in the first 4 weeks ($p = 0.026$), corresponding with the improvement in exercise tolerance. This change was also noted for patients with an MRC score of 2–3 after 12 weeks ($p = 0.027$). Participants with an MRC score of 4–5 registered a significant drop on the Borg scale ($p = 0.037$). Dyspnoea rating at rest registered a significant drop after 8 weeks of rehabilitation, from a score of 0.93 ± 1.33 to 0.05 ± 0.31 ($p = 0.002$). It was only the patients in the most severe group who registered a significant drop in dyspnoea ratings at rest by the 8th week of rehabilitation, from a mean total of 1.46 ± 1.33 to 0 ± 0 at the 8th week ($p = 0.028$).

Health-related quality of life

Significant improvements in health-related quality of life measures were noted as early as the first 4 weeks for the total SGRQ score ($p < 0.001$). Participants with an MRC score of 2–3 registered a significant change in the total score after the 8th week ($p = 0.001$). Those with a higher MRC score registered significant changes as early as 4 weeks of rehabilitation, from a mean total of 51.79 ± 13.30 to 42.14 ± 13.59. This continued to significantly improve through the weeks for both groups

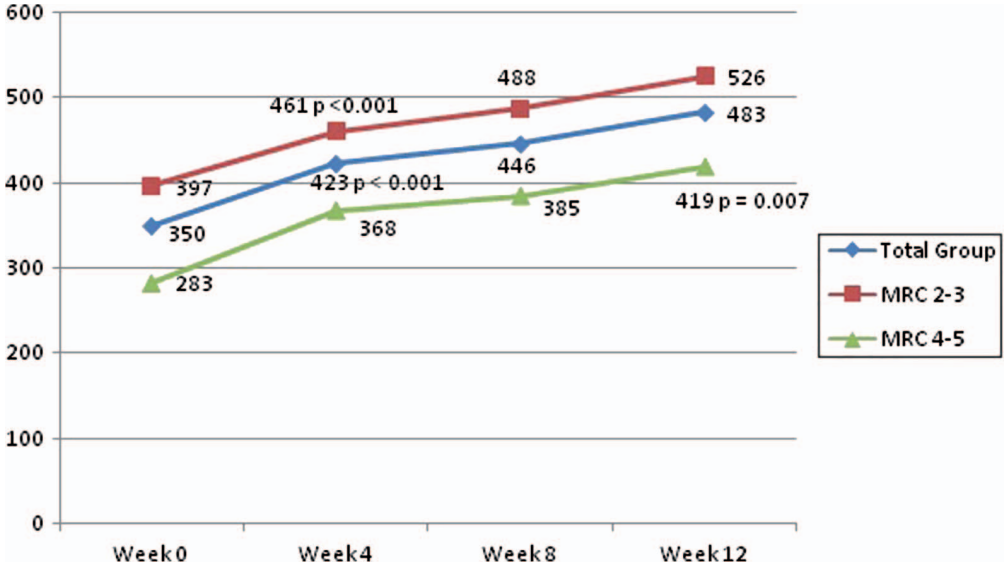

Figure 2. Graph showing the changes in the Total St George's Respiratory Questionnaire score for the whole group and the subgroups with Medical Research Council (MRC) score 2-3 and MRC 4-5. Time-points that registered a statistically significant change have been noted.

(Figure 2). Looking at all the different SGRQ domains, the whole group also registered significant changes by the 4th week of rehabilitation, in the activity score ($p = 0.001$) and the impact and symptom scores ($p = 0.020$ and $p = 0.002$, respectively). Those with an MRC score of 2–3 required 12 weeks of rehabilitation to register a change in the activity score ($p = 0.001$). The more severe group required less time (8 weeks) to register a change in this domain ($p < 0.001$). Changes in the impact score were registered after the 8th week for both groups ($p < 0.001$ and $p = 0.031$, respectively). The more severe patients registered significant changes by the 4th week in their symptom scoring ($p = 0.048$), as opposed to $p = 0.023$ for the milder group.

A significant drop in ratings for the CAT score in the whole group, as well as for the subgroups, resulted from this PR programme. The whole cohort of patients, as well as the subgroups (MRC 2–3 and MRC 4–5), registered a change as early as the first 4 weeks of rehabilitation ($p < 0.001$, $p < 0.001$ and 0.042, respectively).

Anxiety and depression ratings

Significant changes in the anxiety and depression ratings were recorded after 8 weeks of rehabilitation ($p = 0.001$) for both cases. Participants with a severe and very severe COPD rating did not have any significant changes throughout the programme when looking at their anxiety ratings, as opposed to the milder group of patients who had significant changes after 3 weeks of rehabilitation ($p = 0.024$). Participants with an MRC score of 2–3 had significant changes in depression ratings after 12 weeks of rehabilitation ($p = 0.013$), but the more severe group registered earlier changes by the 8th week ($p = 0.013$).

Body mass index, airway Obstruction, Dyspnoea, and Exercise capacity index

Significant changes in the BODE index resulted in the whole group as well as the subgroups by the 8th week ($p < 0.001$ for the whole group, $p = 0.002$ for the subjects with an MRC 2–3 and $p < 0.001$ for the more severe group).

Table I documents the significant changes in the various measures of both the physiological and quality of life outcomes obtained during the PR programme for the patients with different severities of COPD.

Discussion

There is currently no consensus regarding the optimal length of a PR programme for patients with chronic respiratory conditions. This study shows that following a 4 week rehabilitation programme, patients with a milder form of COPD (MRC 2–3) had marked improvements in their exercise tolerance measures, which were then followed up with further improvements in these measures extending through the following 8 weeks of this programme. This also led to changes in health-related quality of life measures. Those with a more severe form of COPD required more time, 12 weeks or slightly longer, to obtain amelioration in functional improvements. These severe patients (MRC 4–5) took longer to increase their exercise tolerance levels, but by the 12th week of rehabilitation there was a significance increase of 136.25 m in their 6MWT, that is, a 48% change in distance from the start ($p < 0.001$).

On the other hand, changes in health-related quality of life measures for the more severe group were reported earlier than in the milder group. These changes did not affect the anxiety levels that the more severe group of patients were reporting at baseline.

These findings correspond well with studies that have looked into these outcome measures irrespective of the duration of the programme (5–21). To our knowledge, aspects of outcomes according to COPD severity have not been looked into in such detail. The benefits of PR were assessed per individual MRC score and the exact time-points at which these significant changes in outcomes occurred are being reported here for the first time.

Changes recorded in the walking distance achieved by the subjects in this study can be attributed to the mastering of dyspnoea when carrying out functional activities throughout the 12 week PR programme. Gains in distance and adaptations towards exercise probably occurred as a result of improved physical status and an altered response to exercise, both of which aid in the control of breathlessness. Other physiological changes such as better cardiac adaptation, decreased lactic acid production and reduction in the metabolic cost of exercise all contribute to these functional improvements (35).

Taken together, all participants had achieved significant changes in both their resting and exertional Borg ratings by the first 4 weeks of the intervention. The different subgroups needed 12 weeks of rehabilitation to achieve statistically significant improvements in exertional dyspnoea levels, with the milder group registering better changes.

Lung function test changes through the 12 weeks of rehabilitation were marginal, despite the addition of the inspiratory muscle trainer. These findings are consistent with many other studies which have looked at lung function changes in COPD patients after PR (1–3,17). A possible cause for lack of change in this area, both in this study as well as in others, could

Table I. Average values of outcome measurements assessed throughout the study at 4, 8 and 12 weeks.

Outcome measure	COPD classification grouping	Week 0	Week 4	Week 8	Week 12	*F* statistic	df1, df2	Partial eta squared	*p*
6MWT	Total group	350.20 ± 109.40	422.86 ± 101.69	446.02 ± 113.29	482.65 ± 127.08	918.85	1, 48	0.950	<0.001
	MRC 2–3	396.55 ± 69.91	461.03 ± 76.96	488.45 ± 99.29	526.38 ± 102.48	1178.11	1, 28	0.977	<0.001
	MRC 4–5	283.00 ± 122.48	367.50 ± 109.30	384.50 ± 105.66	419.25 ± 134.79	274.61	1, 19	0.935	<0.001
Borg scale at rest	Total group	0.92 ± 1.37	0.29 ± 0.79	0.08 ± 0.40	0.29 ± 1.34	20.17	1, 48	0.296	<0.001
	MRC 2–3	0.66 ± 1.26	0.17 ± 0.60	0.07 ± 0.37	0.0 ± 0.00	8.09	1, 28	0.224	0.008
	MRC 4–5	4.55 ± 1.19	3.65 ± 1.60	3.65 ± 1.27	3.05 ± 1.28	430.87	1, 19	0.958	<0.001
Borg scale with exercise	Total group	3.63 ± 1.82	2.69 ± 1.81	2.71 ± 1.53	2.08 ± 1.57	238.64	1, 48	0.833	<0.001
	MRC 2–3	3.00 ± 1.93	2.03 ± 1.66	2.07 ± 1.36	1.41 ± 1.40	108.83	1, 28	0.795	<0.001
	MRC 4–5	4.55 ± 1.19	3.65 ± 1.60	3.65 ± 1.27	3.05 ± 1.28	430.87	1, 19	0.958	<0.001
SGRQ Total score	Total group	43.40 ± 14.88	34.86 ± 16.01	26.81 ± 16.91	22.33 ± 13.37	260.79	1, 48	0.845	<0.001
	MRC 2–3	38.09 ± 13.18	30.73 ± 15.51	24.78 ± 18.26	18.69 ± 13.49	123.30	1, 28	0.815	<0.001
	MRC 4–5	51.10 ± 14.07	40.83 ± 15.13	29.75 ± 14.69	27.60 ± 11.57	179.75	1, 19	0.904	<0.001
SGRQ Activity score	Total group	58.03 ± 18.97	49.86 ± 21.56	42.72 ± 22.75	38.68 ± 21.54	319.92	1, 48	0.870	<0.001
	MRC 2–3	50.75 ± 16.28	44.34 ± 19.76	39.77 ± 24.16	32.01 ± 19.88	175.68	1, 28	0.863	<0.001
	MRC 4–5	68.57 ± 17.89	57.88 ± 22.02	47.01 ± 20.37	48.36 ± 20.57	188.87	1, 19	0.909	<0.001
SGRQ Impact score	Total group	35.65 ± 17.81	27.01 ± 16.47	17.97 ± 15.88	13.45 ± 11.31	158.58	1, 48	0.768	<0.001
	MRC 2–3	29.92 ± 14.63	23.56 ± 15.16	16.30 ± 15.93	10.93 ± 11.98	74.10	1, 28	0.726	<0.001
	MRC 4–5	43.96 ± 19.06	32.02 ± 17.37	20.39 ± 15.88	17.12 ± 9.37	103.68	1, 19	0.845	<0.001
SGRQ Symptom score	Total group	45.76 ± 18.92	34.29 ± 1.55	30.03 ± 21.47	23.00 ± 16.65	217.07	1, 48	0.819	<0.001
	MRC 2–3	41.93 ± 21.34	30.32 ± 24.63	29.64 ± 24.40	20.99 ± 17.22	84.12	1, 28	0.750	<0.001
	MRC 4–5	51.32 ± 13.36	40.04 ± 14.84	30.59 ± 16.92	25.93 ± 15.76	214.42	1, 19	0.919	<0.001
CAT score	Total group	13.90 ± 8.90	8.57 ± 6.72	6.51 ± 6.41	5.33 ± 5.77	100.14	1, 48	0.676	<0.001
	MRC 2–3	11.38 ± 6.15	6.72 ± 5.06	5.00 ± 5.09	4.14 ± 4.52	67.64	1, 28	0.707	<0.001
	MRC 4–5	17.55 ± 10.99	11.25 ± 7.97	8.70 ± 7.55	7.05 ± 6.98	49.66	1, 19	0.723	<0.001
BODE index	Total Group	4.61 ± 2.20	4.27 ± 2.17	3.55 ± 2.18	3.16 ± 1.85	198.41	1, 48	0.805	<0.001
	MRC 2–3	3.69 ± 1.76	3.59 ± 1.99	2.79 ± 1.95	2.38 ± 1.12	119.47	1, 28	0.810	<0.001
	MRC 4–5	5.95 ± 2.11	5.25 ± 2.07	4.65 ± 2.06	4.30 ± 2.13	136.96	1, 19	0.878	<0.001
HAD Anxiety score	Total Group	5.31 ± 4.35	4.27 ± 3.60	3.08 ± 3.05	2.16 ± 2.95	79.56	1, 48	0.624	<0.001
	MRC 2–3	4.83 ± 3.98	3.79 ± 3.47	2.66 ± 2.51	1.52 ± 1.99	50.90	1,28	0.645	<0.001
	MRC 4–5	6.00 ± 4.85	4.95 ± 3.78	3.70 ± 3.67	3.10 ± 3.82	33.37	1, 19	0.637	<0.001
HAD Depression score	Total group	4.10 ± 3.93	2.71 ± 2.94	1.82 ± 2.90	1.14 ± 1.93	51.38	1, 48	0.517	<0.001
	MRC 2–3	2.79 ± 3.32	1.83 ± 2.41	1.31 ± 2.09	0.93 ± 1.67	20.39	1, 28	0.421	<0.001
	MRC 4–5	6.00 ± 4.04	4.00 ± 3.23	2.55 ± 3.72	1.45 ± 2.26	39.28	1, 19	0.674	0.001

Data are shown as mean ± SD.

COPD, chronic obstructive pulmonary disease; df, degrees of freedom; 6MWT, Six-Minute Walk Test distance; MRC, Medical Research Council; SGRQ, St George's Respiratory Questionnaire; CAT, COPD Assessment Tool; BODE, Body mass index, airway Obstruction, Dyspnoea, and Exercise capacity; HAD, Hospital Anxiety and Depression.

relate to the fact that the respiratory muscles of COPD patients are affected by several comorbid factors related to both the presence and severity of COPD. These factors cause impairments in the structure and function of the respiratory muscles.

Using the SGRQ to assess the effects of PR on quality of life, the study identified changes in all domains as early as 4 weeks after commencing the programme. Further significant changes were registered as the programme progressed. Participants with a milder form of COPD took longer to register changes in the quality of life measures. Those with an MRC score of 2–3 registered a significant change after the 8th week ($p = 0.001$) while those with a higher MRC score registered significant changes from as early as the 4th week, from a mean total of 51.10 ± 14.07 to 40.83 ± 15.13. This continued to significantly improve through the weeks of rehabilitation for both groups. Participants with an MRC score of 2–3 obtained significant improvements in the activity score after 12 weeks of rehabilitation ($p < 0.001$), whereas the more severe group registered a significant change before this, that is, following the 3rd week ($p < 0.001$).

Quality of life scores such as the SGRQ identified significant symptom amelioration and functional performance. The improvements started being reported by the 4th week but were further enhanced mostly at the 8th week. This improvement was surely affected by the progress seen in anxiety and depression scores. In the most severe patients, it was impressive to see that there was a marked change in depressive mood by 12 weeks of PR. Since depression is one of the most disabling complaints of these patients, this progress must surely change the complete outlook of these patients towards their quality of life and respiratory condition.

Limitations of the study

Some possible shortcomings that may have influenced the end results include the number of participants in each group together with the lack of compliance by some of them towards the home exercise programme. Various studies have shown that meaningful changes in distance covered during the 6MWT may be influenced by a number of factors, such as sociocultural factors and the level of physical activity before and during the programme.

Conclusion

In conclusion, we have seen that this PR programme was of benefit to our group of patients with different severities of COPD. Patients with mild disease had more marked improvements in functional measures as early as 4 weeks but continued to improve with further rehabilitation. In the more severe COPD group of patients, this improvement in functional performance occurred at a later time-point but their improvement in quality of life measures was more impressive. These results indicate that PR services should be offered to patients according to the severity of their COPD. There is an indication that patients with a milder form or COPD require less time to achieve functional changes but need more input to help to translate this into quality of life gains. This may have an impact both at an individual level and at a global organizational and financial level. Such subdivisions of PR programmes could also result in institutions being able to carry out shorter programmes on bigger numbers of patients with mild COPD concurrently.

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