

Experimental Article

Effect of a short term pulmonary rehabilitation programme on exercise capacity, pulmonary function and health related quality of life in patients with COPD



Bangi A. Naseer, M.P.Th<sup>a</sup>, Abdullah M. Al-Shenqiti, PhD<sup>a</sup>,  
AbdulRahman H. Ali, PhD<sup>a,\*</sup>, Talal M. Al-Jeraisi, MS Otorhinolaryngology<sup>b</sup>,  
Garg G. Gunjan, M.P.Th<sup>c</sup> and Mohammed F. Awaidallah, MD<sup>a</sup>

<sup>a</sup> Faculty of Medical Rehabilitation Sciences, Taibah University, KSA

<sup>b</sup> Head & Neck Surgery Department, Faculty of Medicine, Taibah University, KSA

<sup>c</sup> Jamia Hamdard University, New Delhi, India

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المخلص

**أهداف البحث:** لقد تبين أن المرضى الذين يعانون من مرض الانسداد الرئوي المزمن يستفيدون من برامج إعادة التأهيل الرئوي. هدف هذه الدراسة هو التأكد من تأثير برنامج إعادة التأهيل الرئوي على المدى القصير على القدرة على ممارسة الرياضة، والوظيفة الرئوية ونوعية الحياة في المرضى الذين يعانون من مرض الانسداد الرئوي المزمن.

**طرق البحث:** أُجري اختبار تجريبي قبلي وآخر بعدي على المرضى في العيادات الخارجية بقسم العلاج الطبيعي. ضمت الدراسة ثلاثين مريضاً في حالة مستقرة لمرض الانسداد الرئوي المزمن يعانون من انسداد تدفق الهواء من خفيف إلى شديد (بمتوسط عمر 54.1 ± 5.22). لبرنامج شامل لإعادة التأهيل الرئوي لمدة 6 أسابيع، شملت التعليم والتمرينات. وتضمنت معايير الاستبعاد الحالات القلبية الوعائية التي يمكن أن تتفاقم بسبب ممارسة الرياضة، والعجز الحركي، ونفث الدم، والضعف الإدراكي، وارتفاع ضغط الدم الرئوي الحاد والسرطان النقلي. كما تم تقسيم المرضى عشوائياً إلى مجموعتين تجريبية وضابطة.

**النتائج:** تم قياس السير على الأقدام لمدة 6 دقائق، وقياس الوظيفة الرئوية، ومجموع نقاط استبانة سانت جورج للجهاز التنفسي الحد الأدنى، عند البدء ونهاية الأسبوع الثالث والسادس. وأظهرت النتائج تحسناً كبيراً في السير على الأقدام لمدة 6 دقائق ومجموع نقاط استبانة سانت جورج للجهاز التنفسي.

\* Corresponding address: Examination Control, College of Medical Rehabilitation, PO Box 3893, Almadinah Almunawwarah, KSA.

E-mail: [abraham@hotmail.com](mailto:abraham@hotmail.com) (A.H. Ali)

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**الاستنتاجات:** أظهر البرنامج الشامل لإعادة التأهيل الرئوي لمدة 6 أسابيع تحسناً ملحوظاً في القدرة على ممارسة الرياضة وجودة الحياة بغض النظر عن درجة انسداد تدفق الهواء.

**الكلمات المفتاحية:** البرنامج الشامل لإعادة التأهيل الرئوي؛ مرض الانسداد الرئوي المزمن؛ القدرة على ممارسة الرياضة؛ جودة الحياة؛ الوظيفة الرئوية؛ مجموع نقاط استبانة سانت جورج للجهاز التنفسي

Abstract

**Objectives:** Patients with chronic obstructive pulmonary disease (COPD) have been shown to benefit from pulmonary rehabilitation programmes. The purpose of this study was to ascertain the effects of a short-term pulmonary rehabilitation programme (PRP) on exercise capacity, pulmonary function and quality of life in patients with COPD.

**Methods:** A pre-test and post-test experimental design was conducted on patients from the outpatient physical therapy department. Thirty stable COPD patients with mild to severe airflow obstruction, (mean age 54.1 ± 5.22, FEV<sub>1</sub>, between 0.80 and 0.30 predicted; FEV<sub>1</sub>/FVC < 0.70) were recruited for a 6-week comprehensive pulmonary rehabilitation programme (PRP) that included education and exercise training. Exclusion criteria included the following: cardiovascular conditions likely to be aggravated by exercise, locomotor impairment, haemoptysis, cognitive impairment, severe pulmonary hypertension, and metastatic cancer. The patients were randomly divided into experimental and control groups.

**Results:** Six-minute walk distance (6MWD), pulmonary function (FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC), and St. George's Respiratory Questionnaire (SGRQ) scores were measured at baseline, at the end of the 3rd week and at the end of the 6th week. The results showed significant improvements in 6MWD and SGRQ ( $p < 0.05$ ).

**Conclusion:** A 6-week outpatient-based PRP significantly improves exercise capacity and quality of life, irrespective of the degree of airflow obstruction.

**Keywords:** COPD; Exercise capacity; Pulmonary function; Pulmonary rehabilitation programme; Quality of life; SGRQ

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## Introduction

COPD is the most common cause of mortality and disability associated with lung diseases. The World Health Organization, in a more recent projection, predicts COPD to rise from its recent ranking as the fifth most common cause of mortality to the fourth most common by 2030, which would place it behind only ischaemic cerebrovascular disease, HIV/AIDS and heart disease.<sup>1</sup> Even more importantly, COPD is a rising cause of chronic disability and is predicted to become the fifth most common cause of chronic disability worldwide by 2020.<sup>2</sup> In India, the population prevalence in a large multi-centric study related to COPD was 4.1% of 35 and 295 subjects with a male: female ratio of 1.56:1.<sup>3</sup> The widespread smoking habit and the use of fuel have both led to the high prevalence of COPD.

The loss of physical capacity associated with the adverse psychological effects of the disorder greatly impact the disease. Medicines have a limited role in improving the physical capacity of these patients.<sup>4</sup> The evolving endorsed standard of care for patients with chronic lung disease is pulmonary rehabilitation, based on the developing body of scientific evidence.<sup>5</sup> We perceive that there are many scientific developments where the systemic effects of chronic respiratory disease and the variations that occurred were through the process of pulmonary rehabilitation and Exercise intolerance, predominantly with disease progression, is a hallmark of COPD.<sup>6,7</sup> Abnormalities in cardiac function, ventilatory mechanics, respiratory mechanics, and alveolar gas exchange are present to varying degrees in patients with COPD.<sup>8</sup> The inactivity initiates a concatenation of events where breathlessness increases at even lower physical demands and is associated with progressive deconditioning.

To have an effective rehabilitation programme, exercise reconditioning is the foundation; a physical activity programme ignites the cardiovascular and skeletal muscles so that functional changes in the skeletal system are brought about that reverse the detrimental effects of deconditioning and further systemic manifestations of COPD that affect

skeletal muscles.<sup>9</sup> The management of patients with chronic respiratory disease has developed remarkably, and this extensive mediation has established improvements in exercise performance, reduction in dyspnoea, and recovery of health-related quality of life with evidence-based support for pulmonary rehabilitation.<sup>10</sup>

There is an association between COPD and upper airway symptoms, especially sinonasal symptoms. It is very important to consider the relationship between lower and upper airway inflammation and bacteria. Impairment in quality of life because of COPD could be the primary reason for upper airway symptoms; the nasal and sinus symptoms are considered the most important factor causing impairment to quality of life. Epidemiological studies suggest that more than 1/3 of patients with sinusitis have COPD, and 75% of patients with COPD have associated nasal symptoms. The similarity of the inflammatory response to the lower and upper airways stems from similar exposure to allergens and irritant; in some patients, sinusitis or rhinitis and COPD coexist together, which could be due to the mechanism of nasal bronchial reflex. In this study, we exclude all patients with COPD that have upper airway symptoms.

With the current state of information, an outpatient rehabilitation programme with a multidisciplinary team offers rehabilitation with comparably safe advancements in clinically applicable endpoints, such as health-related quality of life functionality and use of health care assets at an agreeable cost.<sup>11</sup> Since there are no established protocols for pulmonary rehabilitation programmes so far for these patients, the purpose of the present study is to develop a short, comprehensive, and cost-effective pulmonary rehabilitation programme that is more easily accessible for patients with COPD who have a restricted exercise capacity and who otherwise may be required to deal with the high cost of a multidisciplinary programme at a large hospital. For this purpose, an exercise protocol is developed that includes upper limb exercises, thoracic mobility exercises and lower limb endurance exercises totalling 1.5 h in duration as an OPD programme, 3 days per week for 3 consecutive weeks. Later, a home exercise programme is given for another 3 weeks as a maintenance programme. Outcome measures include exercise capacity, HRQOL, pulmonary function as measured by 6MWD, St. George's Respiratory Questionnaire, and spirometry performed at baseline, at the end of the 3rd week and at the end of the 6th week. The data collected is compared to the improvement in the chosen variables. The significance of the study lies in improving the physical and psychological status of the patients, improving their ability to interact with their atmosphere, improving their knowledge of the disease, and refining their self-management strategies. If the study shows significant results, this protocol can be implemented with COPD patients as part of their disease management.

## Materials and Methods

Patients were recruited from Pulmonology OPD. Thirty patients were included in the study, who displayed the following characteristics: stable COPD and mild to severe airflow obstruction; FEV<sub>1</sub> > 30% predicted, FEV<sub>1</sub>/FVC < 70%; optimized medical therapy; dyspnoeic in daily

activities; had never attended any exercise programme; had no associated comorbid disease. Exclusion criteria were cardiovascular conditions that were likely to be aggravated by exercise, locomotor impairment, haemoptysis, cognitive impairment, severe pulmonary hypertension, and metastatic cancer.

The patients included were randomly divided into experimental and control groups. The programme was conducted by a physiotherapist, and patients in the experimental group attended 3 times a week for the first 3 weeks of the pulmonary rehabilitation programme. For the next 3 weeks, they were instructed in a home exercise programme. The patients in the control group were briefed on a home exercise programme for 6 weeks. The pulmonary rehabilitation programme consisted of four repetitions of upper limb exercises (shoulder girdle circling, arm circling) and thoracic mobility exercises each,<sup>12</sup> as well as a lower limb endurance-training programme using a cycle ergometer and treadmill.<sup>13</sup> Patient education and counselling were given to every patient in both groups. Exercise capacity, pulmonary function and health-related quality of life were assessed by the six-minute walk test, FEV<sub>1</sub>, FVC, FEV<sub>1</sub>/FVC, SGRQ scores respectively at baseline, at the end of the 3rd week and at the end of the 6th week.

The six-minute walk test was used for measuring exercise capacity. It was performed in a 30-metre-long, unobstructed hospital corridor. This test was done according to ATS guidelines. Patients were asked to walk as far as they could in 6 min. They could detect their own pace or even stop if they had to, and they were told that at the end of the 6 min they should feel as though they could not have walked any further. Before starting the test, blood pressure, heart rate, oxygen saturation, and RPE were measured. During the test, heart rate and oxygen saturation were measured with a pulse oximeter. After the completion of 6 min, all variables were measured again; distance walked by the patient was noted in metres. The Borg scale was used for the RPE score.

Pulmonary function was assessed by FEV. It was measured by a computerized pulmonary spirometry machine (ZAN300 Me BGE rate GmbH). Values were expressed in percentage predicted. HRQOL was compared using the St. George's Respiratory Questionnaire (SGRQ). Two versions of the questionnaire – Hindi and English – were used for the patients based on their education type. Scores ranged from 0 to 100, with a score of zero indicating no impairment. The total score was used for the analysis.

### Data analysis

Data are represented as descriptive statistics. Statistical analysis was done by SPSS 16. Repeated measures ANOVA were used to assess the changes in outcome measures after the rehabilitation programme from baseline. The differences between the two groups were analysed by independent samples t test.

### Results

Thirty-four patients were recruited for the study, of which 4 patients did not complete the programme. Fifteen patients were included in both the experimental and control group.

**Table 1: Subject characteristics.**

	Group A *Mean ± SD	Group B *Mean ± SD
Sample (n)	15	15
Age (years)	56.53 ± 5.24*	51.67 ± 4.03*
Height (cms)	164.4 ± 6.53*	168.38 ± 4.22*
Weight (kg)	65.2 ± 10.26*	67.63 ± 6.92*
FEV (%predicted)	47.27 ± 11.07*	45.87 ± 8.72*
FVC (%predicted)	67.67 ± 7.42*	64.87 ± 8.98*
6MWD (meters)	336.73 ± 65.92*	317.93 ± 78.54*
SGRQ total score	60.02 ± 17.34*	63.50 ± 16.43*

\*Mean (±SD), p < 0.05; Group A: experimental; Group B: control.

Subject characteristics in both groups are shown in [Table 1](#). At the end of the programme, there were significant changes in 6MWD, HRQOL, and FEV<sub>1</sub> from baseline to the 3rd week ([Table 2](#)).

At the end of 3 weeks, the mean percentage change in 6MWD in the experimental group was 20.56 (5.14) and in the control group was 4.60 (2.03). The mean percentage of the total SGRQ score was 37.39 (10.99) and 8.21 (6.96) for the experimental and control groups, respectively ([Figures 1 and 2](#)). The mean difference between the two groups was statistically significant (p < 0.05). The mean change in 6MWD & SGRQ values within both the groups at the 3rd and 6th week was statistically significant.

### Discussion

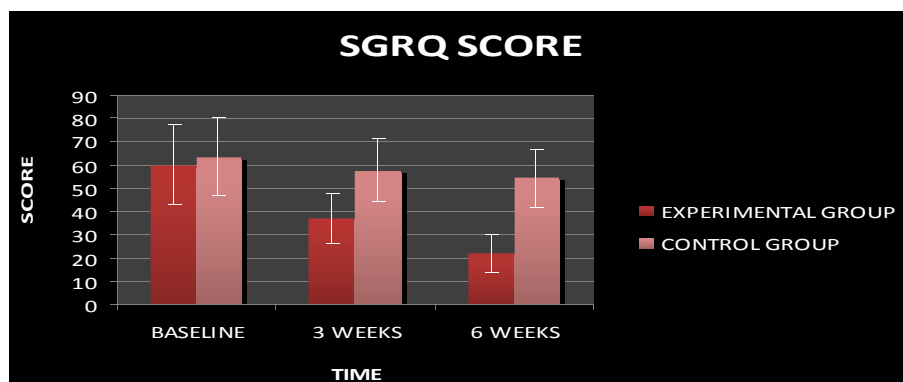
The results have shown that a short-term PRP was able to increase exercise capacity, pulmonary function and quality of life in COPD patients. Scientific evidence was established regarding the benefits of PRPs, as reported by AACVPR practice guidelines for pulmonary rehabilitation. These benefits include a reduction in dyspnoea, improved quality of life, and a decrease in health care use.<sup>14</sup> The present study has shown progress in exercise capacity as measured by percentage change in 6MWD after PRP at the end of 3 weeks (20.56 ± 5.14) and at the end of 6 weeks (27.54 ± 6.93) in the experimental group. These results are in line with Miyahara et al. (2000) who reported an increase in 6MWD as a measure of functional exercise capacity after 3 weeks of PRP in COPD patients.<sup>15</sup> The increase in exercise capacity or tolerance may be ascribed to improved aerobic capacity of muscle, increased motivation, and desensitization to the sensation of dyspnoea.<sup>16</sup> Improved aerobic capacity of muscle has been shown through an increase in the ability of the muscle to extract oxygen more thoroughly from circulating blood,<sup>17</sup> a decrease in heart rate during exercise,<sup>18</sup> a reduction in exercise-induced oxidative stress,<sup>19</sup> exercise-induced lactic acidosis, and enhanced skeletal muscle oxidative capacity in patients with COPD.<sup>20</sup>

Dyspnoea upon exertion was reduced, as reflected in the scores of the QOL questionnaire. Since dyspnoea has a major impact on health status, patients' improved quality of life can be suggestive of a decrease in symptoms. Reduction in dyspnoea, or shortness of breath, can be attributable to reduced ventilatory demand, reduced independence to ventilatory muscle action, improved ventilatory muscle performance

**Table 2: Comparison of 6MWD, SGRQ, FEV<sub>1</sub> between experimental & control group.**

Variable	6MWD		SGRQ		FEV <sub>1</sub>	
	A	B	A	B	A	B
Baseline	336.73* (65.92)	317.93* (78.54)	60.02* (17.34)	63.50* (16.43)	47.27* (11.07)	45.87* (8.72)
3 weeks	403.13* (64.34)	331.73* (79.38)	36.90* (10.69)	57.77* (13.88)	68.13* (7.83)	64.53* (9.12)
6 weeks	425.93* (65.85)	337.60* (80.54)	21.99* (8.26)	54.42* (12.49)	50.20* (12.19)	65.00* (8.41)

\*Mean ( $\pm$ SD),  $p < 0.05$ ; A: experimental; B: control; FEV<sub>1</sub>: forced expiratory volume in one second; FVC: forced vital capacity; 6MWD: 6 minute walk distance; SGRQ: St. George's Respiratory Questionnaire.

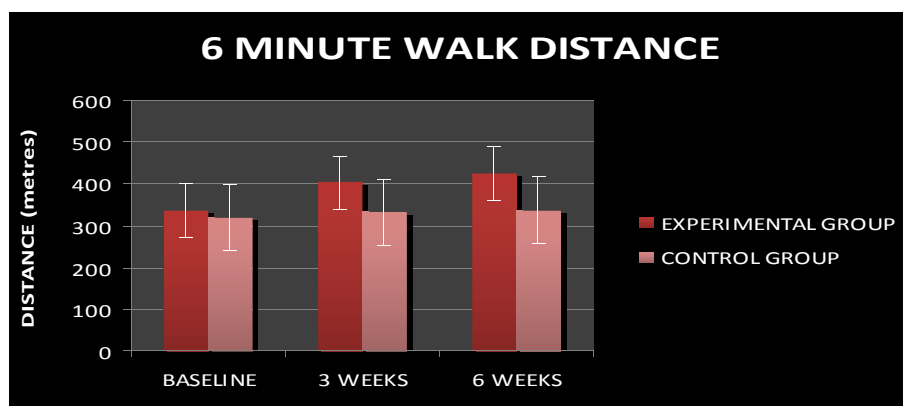
**Figure 1:** Between-group comparison of mean SGRQ score.

characteristics and psychological factors.<sup>21</sup> This study has shown significant improvements in quality of life as measured by a mean percentage change in SGRQ and a disease specific questionnaire at the end of 3 weeks ( $37.39 \pm 10.99$ ) and at the end of 6 weeks ( $62.51 \pm 11.49$ ) compared to baseline ( $60.06 \pm 17.34$ ) in the experimental group. A change of four units on the SGRQ is considered a reliable, noticeable difference.<sup>22</sup> Reduction in dyspnoea, and other symptoms, efficient breathing patterns, and improved ability to carry out daily activities could be reasons for the improvements in quality of life. Knowledge of the disease process, a need for and benefits of medication and exercises, work simplification and energy conservation techniques might be responsible for patients' decreased fear of breathlessness and better control over their disease. Patients who were on their regular medical therapy experienced a decrease in symptoms as measured by better performance in their daily activities and greater

independence in their abilities. A home exercise programme, which included walking and upper limb exercises, may also have contributed to an increase in exercise tolerance to some extent, which ultimately led to a positive impact on patients' quality of life, as suggested by a mean percentage change in the total SGRQ score in the control group at the end of 3 weeks ( $8.21 \pm 6.96$ ) and at the end of 6 weeks ( $13.15 \pm 8.42$ ) compared to baseline ( $63.05 \pm 16.43$ ).

Benefits of PRP include improved exercise capacity and quality of life, irrespective of change in pulmonary function.<sup>17,23,24</sup> In contrast, this study has shown significant changes in FEV<sub>1</sub> after the exercise programme at the end of 3 weeks ( $p < 0.05$ ) and at the end of 6 weeks ( $p < 0.05$ ) in the experimental group. This improvement may be due to improved bronchodilator use<sup>25</sup> or respiratory muscle strength/conditioning.

Apart from an increase in exercise capacity and quality of life, PRP also enhanced patients' knowledge about their

**Figure 2:** Between-group comparison of mean 6MWD.

disease process and motivated them to adopt healthy behaviours<sup>26,27</sup> through patient education and counselling, which may have led them to adhere to the exercise regimen.

An exercise programme for the muscles of ambulation is a part of virtually every programme of pulmonary rehabilitation.<sup>28</sup> In this study, a variety of exercises were incorporated, including treadmill and cycle ergometry, an endurance training programme, upper limb exercises, and thoracic mobility exercises that made this programme more realistic and more functionally relevant to daily activities. Exercise training included arm and leg training, which improves exercise tolerance, and training effects were specific to the muscle group trained without any crossover benefits. In this study, the experimental group had undergone a lower limb endurance exercise programme as well as thoracic mobility and upper limb exercises apart from the home exercise programme, while the control group was taught only about the home exercise programme; unstructured patient education and counselling were done in both groups. As both groups were on medication in addition to the exercise programmes, both groups showed significant improvement in exercise capacity, quality of life and pulmonary function, which is in line with numerous studies showing varied results based on different exercise training programmes, duration and frequency of training and outcome measures used.

### Recommendations and conclusion

Limitations of the study included the small size of the study sample and the availability of male patients. Future research is required to formulate more efficient strategies for rehabilitation that address the individual needs of the patients and to examine the benefits of the individual component of the multidisciplinary rehabilitation programmes.

In conclusion, a short-term pulmonary rehabilitation programme has improved exercise capacity, pulmonary function and quality of life in COPD patients. The improvement in exercise capacity is present, irrespective of the severity of airflow limitation.

### Conflicts of interest

The authors have no conflicts of interest to declare.

### Authors' contributions

BAN, M.P.Th – Conception and design of the work. AA, PhD – Drafting the article with clarifications. AHA, PhD – Data collection, analysis and interpretation. TA, MS – Accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved. GG, M.P.Th – Drafting the work or revising it critically for important intellectual content. MF, MD – Critical vision of the article.

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