DOI: 10.5152/TurkThoracJ.2018.18031

Manuscript type: Original Article

Title: In Which the Gain is more from PR? Asthma or COPD?
Short title: Pulmonary Rehabilitation in COPD and Asthma

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Received: 17.03.2018
Accepted: 01.10.2018

Cite this article as: Deniz S, Şahin H, Polat G, Erbaycu AE. In Which the Gain is More From PR? Asthma or COPD? Turk Thorac J 2018. DOI: 10.5152/TurkThoracJ.2018.18031

Abstract

OBJECTIVES: Pulmonary rehabilitation (PR) is useful for patients with chronic obstructive pulmonary disease (COPD) but not clear for patients with asthma. The aim of the present study was to evaluate the effectiveness of PR in patients with asthma by comparing patients with COPD. The study was designed as a retrospective case series. We recruited patients with COPD and asthma.

MATERIALS AND METHODS: Demographics, respiratory symptoms, medications, smoking history, comorbidities, exercise capacity, respiratory function tests, and quality of life (QOL) were recorded. Exercise capacity was evaluated by the 6-minute walk test (6MWT), QOL with St. George's Respiratory Questionnaire (SGRQ), 36-item Short Form Health Survey (SF-36) Quality of Life Questionnaire, and Hospital Anxiety and Depression (HAD) Scale.

RESULTS: Forty-two patients with asthma and 25 COPD who completed PR were included in the study. There was no difference in terms of age and sex between the groups (p=0.100 and p=0.365, respectively); however, body mass index was higher in the asthmatic group (p=0.007). Partial oxygen pressure (pO_2) difference and arterial oxygen saturation (SpO_2) difference were significantly higher in the COPD group than in the asthma group after PR (p<0.05). When the patients were compared before and after PR in both groups, a significant increase was detected in exercise capacity and QOL (6MWT, HADa, SGRQ, and SF-36 in all domains) (p<0.05). When two groups are contrasted according

to the difference between pre- and post-PR of variables, there was no significant difference except pO_2, SpO_2, and Medical Research Council ($p>0.05$).
CONCLUSION: Physicians refer patients with COPD to PR; however, patients with asthma are not generally referred to the same frequency. We would like to emphasize that PR may be as effective as COPD in asthma.
KEYWORDS: Asthma, COPD, Pulmonary rehabilitation

INTRODUCTION

According to the American Thoracic Society (ATS) and the European Respiratory Society, pulmonary rehabilitation (PR) is a "comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change, designed to improve the physical and psychological condition of individuals with chronic respiratory disease (COPD) and to promote the long-term adherence of health-enhancing behaviors" [1].

There is evidence that physical activity is decreased in COPD [2]. This results to reduced quality of life (QOL), increased rates of hospitalization, and mortality [3,4]. PR enhances exercise capacity, perception of dyspnea, QOL, and anxiety and depression; reduces hospitalization and duration of hospital stay; and accelerates recovery after hospitalization due to exacerbation (evidence A) [5,6].

Asthma leads to intermittent episodes of wheezing, dyspnea, chest tightness, and coughing [7]. Some patients with asthma may avoid physical activity due to dyspnea or for fear of triggering symptoms. Adults with asthma have been reported to have lower levels of physical activity than their peers, in addition to their reduced capacity to overcome daily activities, increased levels of psychological distress, and reduced health-related QOL [8,9]. Regular physical activity reduces the risk of asthma exacerbations in asthma [10].

Although it has long been known that exercise training increases physical fitness in asthma, new data reported that exercise training also has important effects on psychosocial outcomes and symptoms. Two trials showed that exercise training improves asthma symptoms, anxiety, depression, and QOL in individuals with moderate to severe, persistent asthma [11,12].

We aimed to evaluate the efficiency of PR in patients with asthma by comparing patients with COPD.

MATERIAL AND METHODS

This was a retrospective study. Patients referred to the PR unit were included in the study. Sağlık Bilimleri University İzmir Dr Suat Seren Chest Diseases and Thoracic Surgery Research and Educational Hospital approved the study).

Subject Selection

We recruited patients with COPD and asthma. All patients with asthma were enrolled in the study. There were 8 female and 17 male patients with COPD. Only patients with COPD and no other diseases were included. Patients with dyspnea, decreased exercise capacity, and limitation of daily living activities were accepted to the PR program. Patients with both COPD and asthma who were having difficulty in performing daily activities were also included in the study. Patients who were suffering from acute infection and some impairment, such as orthopedic, neurologic, and/or cardiovascular status, that may render the patient incapable of

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completing the exercise training after all patients were examined by a cardiologist and a physical therapist were excluded from the study. Subjects who were having compliance or transportation problems, left the program voluntarily, hospitalized due to infections or other reasons, had to leave due to a newly developed disease, or had financial difficulties were also excluded. All evaluations of patients referred to PR were conducted in our hospital routinely.

Measurements
Demographic data, respiratory complaints, treatments, smoking history, and comorbidities were recorded based on self reports at the beginning of the program. Before inclusion to the PR program, patient data were recorded.

Respiratory Functions
Body plethysmography (Zan 500, Germany) and carbon monoxide diffusion capacity (DLCO) (Zan 300) were recorded. The %predicted values of forced expiratory volume (FEV_1), forced vital capacity (FVC), inspiratory capacity, vital capacity, residual volume, total lung capacity, DLCO, and FEV_1/FVC ratio were recorded before and after PR.

Assessment of Dyspnea
The Medical Research Council (MRC) dyspnea scale, which consists of five items ranging between 1 and 5, was used to determine the severity of patients' shortness of breath. A score of "1" represents the best level and "5" the poorest [13]. After the 6-minute walk test (6MWT), dyspnea scores were evaluated by the Borg Scale [14].

Exercise Capacity
The 6MWT was performed according to the ATS guidelines, and the distance walked for 6 minutes was recorded before and after PR [15].

Quality of Life
The St. George's Respiratory Questionnaire (SGRQ) was used to detect disease-specific QOL [16]. High scores show worsened disease and increased symptoms. The overall QOL was evaluated by the 36-item Short Form Health Survey (SF-36) Quality of Life Questionnaire [17]. Increased scores represent improved QOL.

Psychological Symptoms
The Hospital Anxiety and Depression (HAD) Scale, which consists of 14 questions, was used to determine the psychological status of the patients. Anxiety and depression score is ranked as 0-7: normal, 8-11: borderline, and >11 anxiety or depression [18,19].

Interventions
Pulmonary physiotherapy and rehabilitation sessions, lasting for 2 h, were performed twice a week for 2 weeks to all patients who participated in the program. The exercise program included breathing exercises consisting of pursed-lip, diaphragmatic ventilation and thoracic expansion, relaxation and stretching, peripheral muscle strength, and aerobic exercises. In addition, bronchial hygiene techniques and dyspnea-reducing posture were taught. Bronchial hygiene techniques were applied to all patients with COPD and only required patients with asthma. After respiratory physiotherapy education, upper and lower extremity stretching and strengthening exercises were performed. All strengthening exercises were started without any

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weight. According to the Borg Scale, a half kilogram weight was added every four periods of exercises. The treadmill and bicycle/arm ergometers were used for aerobic exercises [1,6]. Patients were trained at 60%-90% of the maximum heart rate. In addition, we used the Borg dyspnea scores to regulate exercise. Exercise intensity increased according to patient progress. During exercise, we used pulse oximetry to supervise patients (both COPD and asthma), and if arterial oxygen saturation (SpO_2) decreased <90%, oxygen supplementation was provided. Aerobic exercises were performed for 30 min, which consisted of 15-minute treadmill and 15-minute static bicycle exercises [1,6,20]. An arm ergometer was used for patients with joint disorder or lower extremity disability. We aimed to compare gains from PR between asthma and COPD in the present study.

Statistical Analysis

Data were imported to the Statistical Package for the Social Sciences program version 22 (IBM SPSS Statistics Corp., Armonk, NY, USA), and statistical analysis was also made using the same program. Data were presented as mean, standard deviation, median, minimum, and maximum values for continuous variables, and the normal distribution of these variables was examined. Nominal variables were expressed by their frequencies and percentages and compared by cross tables. Independent groups were compared using the chi-square test. A normal distribution for all the variables was not present as explored by a normality test, graphical analysis, and by considering the sample size. Comparison of these variables was performed via nonparametric tests. The Mann-Whitney U test was used in independent groups, and the Wilcoxon signed-rank test was used in repeated measurements. For all the statistical comparison tests, the probability of a type 1 error was $\alpha=0.05$ and two-sided. A p value <0.05 was considered statistically significant.

RESULTS

Forty-two patients with asthma and 25 COPD who completed PR were included in the study (8 male patients in each group). While 27 patients with asthma had comorbidities (hypertension (HT), diabetes mellitus, and coronary artery disease), 9 patients with COPD had the same comorbidities, and there was no significant difference between the groups. The most frequent comorbidity was HT. Oxygen use, hospital admission, and smoking pack-years were higher in patients with COPD ($p<0.05$). There were significant differences in 6MWT, Borg difference, SGRQ in all domains, SF-36 (except general health), HAD, MRC, and asthma control test after PR in asthma (Table 1). Significant differences were also found in partial oxygen pressure (pO_2), SpO_2, Borg difference, SGRQ, SF-36, HAD, and MRC in patients with COPD (Table 2).

When comparing two groups in terms of basal variables, there was no significant difference in terms of age and gender between the two groups ($p=0.100$ and $p=0.365$, respectively); however, there were differences with body mass index (BMI) (higher in asthma), PFT, 6MWT (lower in COPD), SpO_2 difference (higher difference in COPD), and smoking (higher in COPD) (Table 3).

When the groups were compared according to the differences between pre- and post-PR of variables, there were no significant differences (except pO_2, SpO_2, and MRC) ($p>0.05$) (Table 4).

DISCUSSION

Pulmonary rehabilitation improves exercise tolerance, reduces symptoms, and improves the QOL for COPD. It is now recognized increasingly that PR also improves clinical outcomes for individuals with

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many respiratory disorders other than COPD. Although PR programs have a well established role in COPD treatment, studies about PR effects on patients with asthma are sparse [1].

Asthma is one of the most common chronic diseases worldwide with an estimated 300 million people affected [7]. Even though effective medications are available, asthma is still incurable and poorly controlled for many patients [21]. Patients with asthma are commonly enrolled in PR programs in Europe and in North America [22]. Only very few randomized studies regarding the efficiency of multidisciplinary PR program in asthma have been published [23,24].

It is well established that exercise improves physical fitness without any adverse effects on asthma control. Patients with asthma present lower levels of physical fitness and cardiopulmonary conditioning [25]. Low physical activity levels are associated with more symptoms, higher risk of exacerbations, and lower health-related QOL in patients with asthma [26].

Physical exercise improves cardiopulmonary fitness, resulting in lower respiratory rate during activity. With lower respiratory rate during activity, bronchoconstriction during exercise becomes less likely [25]. Recent studies have also showed that regular exercise results in a reduction of airway inflammation, thus improving bronchioles patency [27].

The present study was conducted to assess the effect of PR on patients with asthma and COPD and to determine which gains more from PR. There was no any significance in lung function variables before and after PR of both asthma and COPD groups, which is compatible with the findings in the literature. However, improvement in pO_2 and SpO_2 was significantly higher in the COPD group than in the asthma group after PR. This was attributed to low levels of these values at the beginning in the COPD group. BMI was higher in the asthmatic group as expected.

When patients were compared before and after PR, in both groups, there was a significant change in the QOL, exercise capacity, and anxiety and depression scores. A number of studies have reported significant differences between the groups in the QOL in a mixed group of patients and in patients with COPD in favor of the groups receiving the rehabilitation program [24]. Even though other studies have shown that PR may result to an improvement in the QOL of patients with COPD, the present study showed that these results may also be obtained in patients with asthma. Several questionnaires have been used to detect QOL as outcomes of PR. In the present study, QOL was evaluated by the SGRQ and SF-36. Our results presented an increase in SGRQ scores in both groups, but difference between the two disease groups was not statistically significant.

When compared with pre- and post-PR in two groups separately, patients walked 41 m better in the 6MWT in the asthma group, whereas 57 m better in the pre-PR in the COPD group. These findings were similar with two previous studies [23,24]. The distance walked by the COPD group was significantly higher, but gain in exercise capacity was not significantly higher in the COPD group after PR. This may be clarified by the severity of disease between patients in the asthma and COPD groups. Despite being not statistically significant, anxiety and depression scores improved more in the asthma group. The baseline scores were also higher in the asthma group. It may be said that physical activity improves anxiety and depression scores more in patients with asthma. The symptom evaluated in the present study was dyspnea during activity, since this is the symptom that defines the need for referral to PR according to the British Thoracic Society guidelines [28]. At the end of PR, there was a statistically significant improvement in dyspnea as assessed by the MRC score in two

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groups. In addition, there was a significant difference in favor of the COPD group, meaning that the COPD group gains more according to improvement in symptoms. Anxiety and depression scores were also significantly improved after PR in both disease groups.

In the present study, we cannot provide any results about the effect of PR on emergency service admission and hospital stay because they were beyond the scope of the study. However, in studies conducted on this subject, PR has reduced both emergency room and hospital admissions in both asthma and COPD patient groups [22]. In addition to the two randomized controlled studies, few observational studies have been published [29-32]. They have reported positive effects pertaining to QOL, symptoms, and exercise capacity similar to the present study. In a study of patients with COPD and asthma, as in the present study, similar gains were determined in community-based as in outpatient hospital-based programs [24]. The present study confirms the usefulness of an outpatient-based rehabilitation program.

The present study adds to the evidence that supports the beneficial role of PR in both patients with asthma and COPD. The PR program resulted in improvement in perception of dyspnea, exercise capacity, and life quality with statistical significance in the asthma and COPD groups, but there was no difference between the two groups in terms of gain. Physicians refer patients with COPD to the PR unit; however, patients with asthma are not generally referred to PR in the same frequency. We would like to emphasize that PR may be as effective as COPD in asthma.

Ethics Committee Approval: Authors declared that the research was conducted according to the principles of the World Medical Association Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects", (amended in October 2013)

Informed Consent: Due to the retrospective design of the study, informed consent was not taken.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - H.Ş., S.D.; Design - S.D.; Supervision - S.D.; Resources - H.Ş.; Materials - H.Ş.; Data Collection and/or Processing - H.Ş.; Analysis and/or Interpretation - S.D; Literature Search - S.D.; Writing Manuscript - S.D., G.P.; Critical Review - S.D., G.P., A.E.E.

Conflict of Interest: The authors have no conflicts of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

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Table 1. Comparison of variables between pre- and post-PR in asthma

	Asthma (n=42)				
	Pre-PR		Post-PR		
Variables	Mean±SD	Median (min-max)	Mean±SD	Median (min-max)	p
Age (years)	55.3±10.4	56 (33-75)			
BMI (kg/m^2)	30.8±4.9	32 (20-40)			
Smoking (pack-years)	28.3±22	23 (3-80)			
FEV_1 (%predicted)	78.9±14.1	80 (41-102)	78±14.1	79 (41-100)	0.093
FEV_1/FVC	78.9±7.2	77.5 (67-100)	80.3±9.2	77.5 (66-104)	0.400
IC (%predicted)	92.5±20.5	91 (65-142)	89.1±23.7	86 (51-135)	0.297

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VC (%predicted)	90.4±14.4	89 (70-129)	86.9±12.8	84 (65-108)	0.162
PEF (%predicted)	60.6±21.6	64.5 (29-99)	61±20.1	60 (31-96)	0.850
RV (%predicted)	129.7±46.3	124 (68-228)	131.6±40.4	124 (49-209)	0.545
DLCO	55.6±9.9	55 (40-74)	56.3±10.1	60 (34-73)	0.583
pO_2 (mmHg)	83.3±8.2	84.5 (67-100)	83.7±10.6	84.5 (60-109)	0.769
pCO_2 (mmHg)	38±4.4	38.4 (27-46)	38.5±4.2	39 (30-49)	0.605
SpO_2 (%)	96.4±1.5	96.7 (93-100)	96.1±1.8	96 (91-99)	0.519
pH	7.40±0.04	7.42 (7.35-56)	7.41±0.04	7.41 (7.32-51)	0.711
6MWT (m)	374±93	375 (120-550)	415±96	415 (88-570)	**<0.001**
Borg difference	1.7±1.5	1 (0-4.5)	1.2±1.1	1 (0-4)	**0.003**
Pulse difference	18.5±10.4	16 (3-40)	23.2±10.9	21.5 (4-51)	0.075
SpO_2 difference	0.6±1.5	1 (−3-4)	0.7±1.7	0.5 (−3-7)	0.765
SGRQ					
Symptom	58.6±21.5	61.2 (13-93)	48.9±17.7	51.4 (9-86)	**<0.001**
Activity	66.9±23.4	66.9 (7-100)	52.4±26.9	53.5 (0-100)	**<0.001**
Impact	50.3±23	50 (13-93)	37.6±24.2	35.6 (4-91)	**<0.001**
Total	56.7±20.8	58.1 (13-94)	44±22.4	48 (7-90)	**<0.001**
SF-36					
Physical functioning	48.6±29.8	55 (0-95)	63.4±29.8	70 (0-100)	**<0.001**
Social functioning	56.5±27.5	62.5 (0-100)	65.4±25.4	62.5 (13-100)	0.050
Role physical	23.8±37	0 (0-100)	55.3±44.3	75 (0-100)	**<0.001**
Role emotional	29.6±39.6	0 (0-100)	57.1±41.1	66.6 (0-100)	**<0.001**
General health	38.5±25.9	35.5 (−25-92)	43.6±27	47.5 (−25-97)	0.063
Mental health	53±23.8	52 (16-100)	61.7±24.8	66 (12-100)	**0.015**
Bodily pain	51.1±29.9	41 (0-100)	66.6±25.7	67 (22-100)	**<0.001**
Vitality	43.2±28.4	37.5 (0-100)	58.6±22	57.5 (15-100)	**<0.001**
HADa	9.5±5.5	8.5 (1-21)	7.3±4.6	6.5 (0-19)	**<0.001**
HADd	7.7±4	8 (0-20)	5.9±4.1	5.5 (0-16)	**<0.001**
MRC	2.9±1.1	3 (1-5)	2.2±1	2 (1-5)	**<0.001**
ACT	14.1±5.5	13.5 (5-23)	20.2±4.2	21.5 (9-25)	**<0.001**

BMI: body mass index; FEV_1: forced expiratory volume; FVC: forced vital capacity; IC: inspiratory capacity; VC: vital capacity; PEF: peak expiratory flow; RV: residual volume; DLCO: carbon monoxide diffusion capacity; % pred: percent predicted; pO_2: partial oxygen pressure; pCO_2: partial arterial carbon dioxide pressure; SpO_2: arterial oxygen saturation; 6MWT: 6-minute walk test; SGRQ: St. George's Respiratory Questionnaire; SF-36: 36-item Short Form Health Survey; HAD: Hospital Anxiety and Depression Scale; MRC: Medical Research Council; ACT: asthma control test

Table 2. Comparison of variables between pre- and post-PR in COPD

	COPD (n=25)				
	Pre-PR		Post-PR		
Variables	Mean±SD	Median (min-max)	Mean±SD	Median (min-max)	p
Age (years)	59.5±6.8	60 (47-72)			
BMI (kg/m^2)	27.2±5.1	26 (18-39)			

Smoking (pack-years)	43.3±27.6	38 (10-100)			
FEV_1 (%predicted)	45.7±16.2	47 (20-68)	46.7±15.7	48.5 (21-73)	0.074
FEV_1/FVC	57.4±9.2	61.5 (40-67)	59±9.8	62 (33-71)	0.246
IC (%predicted)	65.5±22.8	61 (39-107)	67.5±22.6	65 (40-114)	0.492
VC (%predicted)	70±20.4	71 (41-119)	71.7±19.9	69 (39-118)	0.381
PEF (%predicted)	38.8±12.1	40 (14-58)	43.8±11.8	44 (24-65)	**0.013**
RV (%predicted)	158.8±53.2	146 (85-273)	151.8±53.8	147 (49-260)	0.122
DLCO	40.8±13.8	44 (17-66)	38.8±14	41 (17-64)	0.069
pO_2 (mmHg)	73.6±12	74 (51-96)	78.7±11.7	78 (54-102)	**0.004**
pCO_2 (mmHg)	42.2±7.2	39 (31-56)	40.4±5	40 (32-50)	0.179
SpO_2 (%)	94.6±2	94.9 (91-98)	95.8±2	96.2 (91-99)	**0.006**
pH	7.41±0.02	7.41 (7.38-46)	7.40±0.03	7.41 (7.34-45)	0.326
6MWT (m)	325±93	320 (120-470)	382±96	400 (100-520)	**<0.001**
Borg difference	2.1±1.1	2 (0-4)	1.3±1.1	1.5 (0-3)	**0.018**
Pulse difference	16.3±7.2	17.5 (3-31)	18.9±12.2	16 (2-52)	0.397
SpO_2 difference	2.3±2.4	2 (−2-7)	2.7±2.4	2 (−1-9)	0.453
SGRQ					
Symptom	55.2±16.8	56.7 (21-81)	45.9±17.5	43.3 (5-94)	**0.010**
Activity	71.3±21.9	72.8 (13-100)	52.7±26.4	48.4 (0-100)	**<0.001**
Impact	48.2±18.7	45.9 (16-82)	32.9±20.9	28.5 (4-77)	**<0.001**
Total	56.3±17.1	56.6 (20-87)	41.1±20.4	41.5 (6-87)	**<0.001**
SF-36					
Physical functioning	41.5±26.8	35 (0-95)	63.2±28.1	65 (0-100)	**<0.001**
Social functioning	53.8±30.7	50 (0-100)	76±21.9	75 (25-100)	**0.003**
Role physical	22.8±36.8	0 (0-100)	69.5±38.4	75 (0-100)	**0.001**
Role emotional	24.6±35.1	0 (0-100)	65.2±34	66.6 (0-100)	**0.002**
General health	42.1±24.6	40 (0-85)	56.4±23.5	56 (5-95)	**0.002**
Mental health	54.9±23.6	52 (8-96)	70.2±23.7	76 (24-100)	**0.001**
Bodily pain	43.3±21.9	42 (0-100)	66.6±24.3	62 (22-100)	**0.001**
Vitality	40±25	50 (0-80)	61.7±22.9	65 (15-100)	**<0.001**
HADa	8±4.5	8 (0-20)	6.2±4.5	5 (1-18)	**0.011**
HADd	7±4.7	8 (1-15)	5.7±4.6	6 (0-19)	0.143
MRC	3.2±0.9	3 (1-5)	2.1±1	2 (1-4)	**<0.001**

BMI: body mass index; FEV_1: forced expiratory volume; FVC: forced vital capacity; IC: inspiratory capacity; VC: vital capacity; PEF: peak expiratory flow; RV: residual volume; DLCO: carbon monoxide diffusion capacity; % pred: percent predicted; pO_2: partial oxygen pressure; pCO_2: partial arterial carbon dioxide pressure; SpO_2: arterial oxygen saturation; 6MWT: 6-minute walk test; SGRQ: St. George's Respiratory Questionnaire; SF-36: 36-item Short Form Health Survey; HAD: Hospital Anxiety and Depression Scale; MRC: Medical Research Council

Table 3. Comparison of basal values between patients with COPD and asthma

Variables	Asthma (42)		COPD (25)		
	Mean±SD	Median (min-max)	Mean±SD	Median (min-max)	p
Age (years)	55.3±10.4	56 (33-75)	59.5±6.8	60 (47-72)	0.100

BMI (kg/m^2)	30.8±4.9	32 (20-40)	27.2±5.1	26 (18-39)	**0.007**
Smoking (pack-years)	28.3±22	23 (3-80)	43.3±27.6	38 (10-100)	0.079
FEV_1 (%predicted)	78.9±14.1	80 (41-102)	45.7±16.2	47 (20-68)	**0.000**
FEV_1/FVC	78.9±7.2	77.5 (67-100)	57.4±9.2	61.5 (40-67)	**0.000**
IC (%predicted)	92.5±20.5	91 (65-142)	65.5±22.8	61 (39-107)	**0.001**
VC (%predicted)	90.4±14.4	89 (70-129)	70±20.4	71 (41-119)	**0.001**
PEF (%predicted)	60.6±21.6	64.5 (29-99)	38.8±12.1	40 (14-58)	**0.003**
RV (%predicted)	129.7±46.3	124 (68-228)	158.8±53.2	146 (85-273)	0.075
DLCO	55.6±9.9	55 (40-74)	40.8±13.8	44 (17-66)	**0.001**
pO_2 (mmHg)	83.3±8.2	84.5 (67-100)	73.6±12	74 (51-96)	**0.001**
pCO_2 (mmHg)	38±4.4	38.4 (27-46)	42.2±7.2	39 (31-56)	**0.041**
SpO_2 (%)	96.4±1.5	96.7 (93-100)	94.6±2	94.9 (91-98)	**0.001**
pH	7.40±0.04	7.42 (7.35-56)	7.41±0.02	7.41 (7.38-46)	0.498
6MWT (m)	374±93	375 (120-550)	325±93	320 (120-470)	**0.049**
Borg difference	1.7±1.5	1 (0-4.5)	2.1±1.1	2 (0-4)	0.244
Pulse difference	18.5±10.4	16 (3-40)	16.3±7.2	17.5 (3-31)	0.670
$SatO_2$ difference	0.6±1.5	1 (−3-4)	2.3±2.4	2 (−2-7)	**0.005**
SGRQ					
Symptom	58.6±21.5	61.2 (13-93)	55.2±16.8	56.7 (21-81)	0.391
Activity	66.9±23.4	66.9 (7-100)	71.3±21.9	72.8 (13-100)	0.484
Impact	50.3±23	50 (13-93)	48.2±18.7	45.9 (16-82)	0.742
Total	56.7±20.8	58.1 (13-94)	56.3±17.1	56.6 (20-87)	0.896
SF-36					
Physical functioning	48.6±29.8	55 (0-95)	41.5±26.8	35 (0-95)	0.253
Social functioning	56.5±27.5	62.5 (0-100)	53.8±30.7	50 (0-100)	0.724
Role physical	23.8±37	0 (0-100)	22.8±36.8	0 (0-100)	0.849
Role emotional	29.6±39.6	0 (0-100)	24.6±35.1	0 (0-100)	0.744
General health	38.5±25.9	35.5 (−25-92)	42.1±24.6	40 (0-85)	0.656
Mental health	53±23.8	52 (16-100)	54.9±23.6	52 (8-96)	0.726
Bodily pain	51.1±29.9	41 (0-100)	43.3±21.9	42 (0-100)	0.508
Vitality	43.2±28.4	37.5 (0-100)	40±25	50 (0-80)	0.645
HADa	9.5±5.5	8.5 (1-21)	8±4.5	8 (0-20)	0.382
HADd	7.7±4	8 (0-20)	7±4.7	8 (1-15)	0.483
MRC	2.9±1.1	3 (1-5)	3.2±0.9	3 (1-5)	0.309

BMI: body mass index; FEV_1: forced expiratory volume; FVC: forced vital capacity; IC: inspiratory capacity; VC: vital capacity; PEF: peak expiratory flow; RV: residual volume; DLCO: carbon monoxide diffusion capacity; pO_2: partial oxygen pressure; pCO_2: partial arterial carbon dioxide pressure; SpO_2: arterial oxygen saturation; 6MWT: 6-minute walk test; $SatO_2$: oxygen saturation; SGRQ: St. George's Respiratory Questionnaire; SF-36: 36-item Short Form Health Survey; HAD: Hospital Anxiety and Depression Scale; MRC: Medical Research Council

Table 4. Comparison of differences between pre- and post-PR of variables

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record. Please cite this article as: Deniz S, Şahin H, Polat G, Erbaycu AE. In Which the Gain is More From PR? Asthma or COPD? Turk Thorac J 2018. DOI: 10.5152/TurkThoracJ.2018.18031

Variables	Asthma (42) Mean±SD	Median (min-max)	COPD (25) Mean±SD	Median (min-max)	p
Δ FEV_1	−1.9±5.5	−1.5 (−13-8)	1.3±3.2	1.5 (−4-5)	0.09
Δ FEV_1/FVC	1.45±6.9	0 (−14-21)	0.9±2.2	1 (−12-16)	0.56
Δ IC	−3.4±0.45	−5 (−28-22)	1.9±11.4	2 (−21-25)	0.16
Δ VC	−3.4±10.2	−3 (−22-19)	1.7±8.3	1 (−17-20)	0.10
Δ PEF	0.3±7.7	−0.5 (−15-14)	5±6.9	6 (−12-16)	0.06
Δ RV	1.9±30.9	4 (−59-60)	−7.2±20.7	−7.5 (−49-39)	0.15
Δ DLCO	0.7±8.1	1 (−18-18)	−2±4.4	−1 (−16-3)	0.14
Δ pO_2	0.3±8.9	−0.7 (−20-19)	5±9.1	5.3 (−21-25)	**0.04**
Δ pCO_2	0.4±4.4	0.2 (−8-97)	−1.8±5.9	−2.6 (−12.5-9)	0.16
Δ SpO_2	−0.2±1.8	0 (−3.5-3)	1.3±2.2	1 (−4-6.9)	**0.02**
Δ pH	0±0.04	0 (−0.1-0.09)	−0.01±0.04	0 (−0.09-0.05)	0.74
Δ 6MWT	41.1±28.6	40 (−32-100)	57±39.5	50 (−20-150))	0.09
Δ Borg difference	−0.6±1.2	−0.2 (−3-1)	−0.8±1.4	−1 (−3.5-2)	0.35
Δ Pulse difference	6.1±12.5	2 (−12-35)	2.6±12.9	2 (−19-28)	0.59
Δ SpO_2 difference	0.1±1.8	0 (−5-4)	0.04±2.4	0 (−5-5)	0.82
SGRQ					
Δ Symptom	−9.7±17.2	−8.5 (−47-45.1)	−9.3±16.2	−10 (−55-17.5)	0.90
Δ Activity	−14.4±19.8	−7.2 (−68.4-19)	−18.6±17.4	−14 (−67.5-6)	0.25
Δ Impact	−12.7±19.5	−11 (−75-35.2)	−15.3±15.2	−15 (−42-14.3)	0.41
Δ Total	−12.7±16.4	−9.6 (−66-23.8)	−15.3±12.2	−15 (−39-8.8)	0.34
SF-36					
Δ Physical functioning	14.7±24	12.5 (−35-85)	21.7±19.4	25 (−10-65)	0.18
Δ Social functioning	8.9±25.2	12.5 (−50-50)	22.2±30	12.5 (−25-87)	0.21
Δ Role physical	31.5±43.8	12.5 (−50-100)	46.7±41.5	50 (0-100)	0.17
Δ Role emotional	27.5±39.8	0 (−33.3-100)	40.5±46	33.3 (−33-100)	0.23
Δ General health	5.1±17.2	7.5 (−32-37)	14.3±17.6	11 (−20-52)	0.10
Δ Mental health	8.6±20.5	6 (−36-52)	15.3±19.5	16 (−16-76)	0.22
Δ Bodily pain	15.5±20.9	15.5 (−32-68)	23.2±25.7	22 (−39-68)	0.13
Δ Vitality	15.4±20.4	14.5 (−20-65)	21.7±20.6	15 (0−85)	0.29
Δ HADa	−2.2±3.8	−1.5 (−14-8)	−1.8±2.9	−2 (−7-4)	0.90
Δ HADd	−1.8±2.8	−1.5 (−11-3)	−1.2±3.7	−1 (−9-6)	0.40
Δ MRC	−0.7±0.8	−1 (−3-0)	−1±0.5	−1 (−2-0)	**0.02**

FEV_1: forced expiratory volume; FVC: forced vital capacity; IC: inspiratory capacity; VC: vital capacity, PEF: peak expiratory flow; RV: residual volume; DLCO: carbon monoxide diffusion capacity; pO_2: partial oxygen pressure; pCO_2: partial arterial carbon dioxide pressure; SpO_2: arterial oxygen saturation; 6MWT: 6-minute walk test; SGRQ: St. George's Respiratory Questionnaire; SF-36: 36-item Short Form Health Survey; HAD: Hospital Anxiety and Depression Scale; MRC: Medical Research Council

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