doi: 10.30934/kusbed.619753 **e-ISSN:** 2149-8571

Kocaeli Üniversitesi Sağlık Bilimleri Dergisi

Özgün Araştırma / Original Article

http://dergipark.gov.tr/kusbed

EFFICACY OF PULMONARY EXERCISES IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE

KRONİK OBSTRÜKTİF AKCİĞER HASTALARINDA SOLUNUM EGZERSİZLERİNİN ETKİNLİĞİ

Ilgın Sade[1*], Esin Sirintas[2], Murat Inanir[3], Cigdem Cekmece[4], Ilknur Basyiğit[5]

[1]University of Kocaeli, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Kocaeli, Turkey, [2]Golcuk Necati Celik State Hospital, Halidere Physical Therapy Rehabilitation and Community Mental Health Center, Kocaeli, Turkey, [3]University of Kocaeli, Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Kocaeli, Turkey, [4]University of Kocaeli, Yahya Kaptan Vocational School, Kocaeli, Turkey, [5]University of Kocaeli, Faculty of Medicine, Department of Chest Diseases, Kocaeli, Turkey

ORCID iD: Ilgın Sade: 0000-0002-9004-8248; Esin Sirintas: 0000-0003-3307-3372; Murat Inanir: 0000-0002-9162-7129; Cigdem Cekmece: 0000-0003-2865-480X; Iknur Basyigit: 0000-0001-7706-9311

***Sorumlu Yazar / Corresponding Author:** Ilgın Sade, **e-posta / e-mail:** ilginsade@gmail.com

Geliş Tarihi / Received: 20.09.2019 **Kabul Tarihi / Accepted:** 30.12.2019 **Yayım Tarihi / Published:** 12.01.2020

Abstract

Objective: The aim of this study was to determine the effectiveness of pulmonary rehabilitation on respiratory parameters, aerobic exercise capacity, quality of life and psychological status of the patients with chronic obstructive pulmonary disease (COPD). The addition of aerobic exercise on pulmonary exercises was also evaluated to provide further improvements on these parameters.
Methods: Sixty-five patients were randomly assigned to carry out pulmonary exercise, combined (respiratory plus aerobics) and, a control groups. Demographic characteristics were noted. Respiratory function tests, maximal inspiratory pressure (PImax) and maximal expiratory pressure (PEmax) values and, exercise tolerance test (ETT) were assessed. Medical Research Council (MRC) dyspnea scale, body mass index (B), airway obstruction (O), dyspnea scale (D), exersice capacity (E) (BODE) index, Short Form 36 (SF-36), and Saint George Respiratory Questionnaire (SGRQ) obtained from each patient were recorded before the treatment, and after the 8-week treatment.
Results: After the treatment significant increases were found in forced expiratory volume-one second (FEV1), FEV1/forced vital capacity (FVC) ratio, PImax, PEmax values in pulmonary and combined exercise groups, and FVC, vital capacity (VC) values in combined exercise group (p<0.05 for all parameters). Statistical differences were observed in both exercise groups regarding MRC Dyspnea score, Maksimum Equivalent Task (MET) values, SGRQ and some parameters of SF-36 (p<0.05 for all parameters). In the control group no noticeable difference was observed in any of the parameters. After treatment there was no difference between pulmonary and combined exercise group in any parameters (p<0.05).
Conclusion: Both pulmonary and combined exercise programs improved exercise capacity, dyspnea, and the life quality of the COPD patients.

Keywords: *Chronic Obstructive Pulmonary Disease, Dyspnea, Exercise, Pulmonary rehabilitation*

Öz

Amaç: Bu çalışmada KOAH'lı hastalarda solunum egzersizleri ile bunlara ilave aerobik egzersizlerin solunum parametreleri, aerobik kapasitesi, yaşam kalitesine ve hastanın psikolojik durumu üzerine olan etkinliğinin araştırılması amaçlandı.
Yöntem: Altmış beş hasta pulmoner egzersiz, kombine egzersiz (pulmoner+aerobik egzersiz) ve kontrol grubu olmak üzere 3 gruba randomize edildi. Demografik veriler kaydedildi. Solunum fonksiyon testleri, maksimal inspirasyon basıncı (PİmaX), PEmax (maksimal ekspirasyon basıncı) ve Egzersiz Tolerans Testi (ETT) değerlendirildi. Medical Research Council (MRC) Dispne Skalası, modifiye Bruce ETT ve 6 dakika yürüme testi ile egzersiz kapasiteleri, vücut kitle indeksi (B), obstrüksiyon (O), dispne skalası (D), egzersiz kapasitesi (E) BODE indeksi, Kısa Form-36 (KF-36), Saint George Solunum Sorgulaması (SGRS) ile yaşam kalitesi parametreleri tedavi öncesi ve 8 haftalık tedavi sonrası kaydedildi.
Bulgular: Tedavi sonrası pulmoner egzersiz ve kombine egzersiz grubunda 1. Saniye zorlu ekspiratuvar volüm (FEV1), FEV1/zorlu vital kapasite (FVC), PİmaX, PEmax; kombine egzersiz grubunda FVC, vital kapasite (VK) değerlerinde istatistiksel olarak anlamlı artış tespit edildi (tüm parametreler için p<0,05). Her iki egzersiz grubunda MRC dispne skalası, Metabolik eşdeğer MET değerleri, SGRS ve KF-36 bazı parametrelerinde istatistiksel olarak anlamlı fark gözlendi (tüm parametreler için p<0,05). Kontrol grubunda incelenen parametrelerin hiçbirinde anlamlı gözlenmedi. Tedavi sonrası parametrelerde pulmoner ve kombine egzersiz grubu arasında fark saptanmadı (p>0,05).
Sonuç: Solunum ve kombine (solunum+ aeorobik) egzersiz uygulamalarının KOAH'lı hastalarda egzersiz kapasitesi, dispne ve yaşam kalitesini anlamlı şekilde artırdığı saptanmıştır.

Anahtar Kelimeler: *Kronik Obstrüktif Akciğer Hastalığı, Dispne, Egzersiz, Pulmoner rehabilitasyon*

Introduction

Chronic obstructive pulmonary disease (COPD), one of the leading causes of mortality and morbidity esp., in developing industrial countries is an important community health problem.1 Prevalence of COPD and morbidity and mortality rates vary among countries. Limitation of physical activity causes several problems such as isolation, depression, and a life restricted in home. Pharmacological treatments may improve the lung functions of patients with COPD, but such treatments restrict effects on exercise capacity, and the quality of life.[1,2,3]

The importance of pulmonary rehabilitation programs, which are applied to improve functional restrictiveness, is gradually increasing.[3,4] Pulmonary Rehabilitation Programs consist of patient education, psychological support, pulmonary rehabilitation, as well as aerobics and strengthening exercises. In addition to the exercise program, patients are instructed on relaxation techniques, and right breathing patterns.[5,6] In addition to patient education and pulmonary rehabilitation, the inclusion of the optimal exercise technique in the pulmonary rehabilitation program has been controversial. Pulmonary rehabilitation and the strengthening exercise are proven to have positive effects on quality of life and exercise capacity. However it is not clear whether the addition of aerobic exercise provides significant contribution to lung functions, quality of life, dyspnea perception, exercise capacity and respiratory muscle strength.[3,4,5]

The objective of this prospective study was to determine the effectiveness of the chest physiotherapy on respiratory parameters, aerobic exercise capacity, quality of life and psychological situation of the patients with COPD, and to evaluate whether the addition of aerobic exercise on pulmonary exercise provides further improvements on these parameters.

Methods

A total of 100 patients diagnosed with COPD and followed up by the Pulmonary Disease Department of Kocaeli University were evaluated in their eligibility for the participation to pulmonary rehabilitation program in the Physical Medicine and Rehabilitation Department between February 2009 and October 2009. Sixty-five of the patients met the inclusion criteria, and agreed to participate to the study. The inclusion criteria used being over 40 years of age, post bronchodilator forced expiratory volume one second (FEV1))/forced vital capacity (FVC) ratio value of < 70%, and a FEV1 value between 30-80% (stage 2-3 according to GOLD criteria)[7]. Patients who suffered from lung diseases other than COPD, had serious cardiac problems (heart failure, unstable hypertension, angina, and myocardial infarction), and serious medical conditions including infection within the last 4 weeks were excluded from the study. Patients with physical restriction for aerobic exercises on treadmill were also excluded. Ethical approval for the study was granted by the ethical committee of Kocaeli University Faculty of Medicine (Ethical Committee of Clinical Researches No: 5/22). Informed consent was obtained from each participant. The study is held in compliance with the Declaration of Helsinki.

The three study groups were simply formed by tossing a coin according to randomization rules. The first group (pulmonary exercise group) consisted of 21 patients who received respiratory exercises training. The second group (the combined exercise group) consisted of 23 patients who received both respiratory exercise training and aerobic exercise. The third group (control group) consisted of 21 patients who received standart medical care for COPD.

Demographic characteristics of the patients namely age, gender, body mass index (BMI), duration of disease, smoking status and medication were recorded. All patients received bronchodilator therapy including inhaled long-acting anticholinergic, inhaled long-acting beta-2 agonist and oral theophylline as monotherapy, or in combination according to their disease severity determined by GOLD classification. Patients with frequent exacerbation and/or partial reversibility in lung function test received combined formulation of inhaled corticosteroid and beta-2 agonist. Physical examination, body mass index (BMI), chest x-ray, electrocardiography, spirometry test, maximal inspiratory pressure (PImax) and maximal expiratory pressure (PEmax) were performed. Exercise tolerance test (ETT) on treadmill were applied to participants in order to evaluate exercise capacity. The exercise test is terminated when (1) symptoms were limiting the patient from continuing; (2) when formal termination criteria were fulfilled or (3) when the test was completed.

Spirometry was performed with Vmax 20C spirometry (Sensormedics, CA). FEV1, FVC, FEV1/FVC and vital capacity (VC) were evaluated. In order to determine the postbronchodilator levels of lung functions, spirometry test was re-performed 15 minutes after the inhalation of 4 puffs (400 mcg) of salbutamol (Ventolin inhaler®, GlaxoSmithKline). Respiratory muscle strength was evaluated with PImax and PEmax using body pletismography (ZAN body pletismography, Germany).

Exercise capacity of the patients were evaluated with ETT which was based on modified Bruce exercise protocol. Patients were monitorized with electrocardiogram which has 12 derivations. Parameters recorded at; before exercise, during exercise and in the normalizing period. Otherwise, arterial blood pressure recorded at; before the ETT, every three minutes during test and in the normalizing period with manual sphygmomanometer. Test was terminated when the patient's heart rate reached the target level during effort or in case of existing any symptoms or signs like; chest pain, gasping, excessive fatigue, frequent ventricular ectopic beats. The maximum metabolic equivalent task (MET) level was recorded. Fatigue and dyspnea established with the Modified Borg Scale.

The dyspnea level of patients was evaluated with Medical Research Council (MRC) scale.[8] Short-Form–36 (SF–36) and St. George Respiratory Questionnaire (SGRQ) were used to evaluate quality of life in this study.9,10 Furthermore, BODE index which originates from index letters of BMI, obstruction (FEV1 level), dyspnea (MRC scale) and exercise capacity (6 minute walking test) parameters were also calculated.[11] All assessments were performed for each patient at baseline and at the end of treatment program.

Pulmonary rehabilitation program: Patient's self-management education consisted of breathing strategies including pursed lip breathing, diaphragmatic breathing, lateral costal breathing and postural drainage techniques. The exercises were provided by means of a compact disc. After determination of home exercise program, patients in the pulmonary exercise group were invited to outpatient clinic control visits once a week. In addition to that, exercise

status has been checked by phone calls twice a week for the patient to adhere the treatment.

Aerobic exercise program was performed on a walking band for 8 weeks, and 3 days a week for 40 minutes (5-minute warm-up, 30-minute maximal effort, 5-minute cool-down). Aerobic exercise intensity was defined by the method of maximum heart rate. Based on data from the American Association of Sports Medicine, exercise intensity was adjusted with respect to 60-85% of maximum heart rate of patients involved in aerobic exercise program. During the exercise program, heart rates and blood pressure levels were measured by means of a manual sphygmomanometer with 10-minute intervals. Patients were controlled in case of possible symptoms. When the exercise program was completed, patients were allowed to rest in seated position for 10 minutes, after which blood pressure and heart rate were measured again. Patient's perceived degree of strain was determined by using the Modified Borg Scale. An experienced physical therapist supervised all exercises administration.

Statistical Analysis

Demographic data were shown as a mean ± standard deviation. Kolmogorov-Smirnov test was used to assess normality and none of the parameters were found to be normally distributed. We compared the baseline characteristics of each group using Kruskal-Wallis analysis of variance for categorical variables. Mann Whitney U Test (with correction of Bonferroni) was used in between-group analyses, and Wilcoxon Signed Ranks Test was used in within-group analyses. A value of $p<0.05$ was considered statistically significant.

Results

The study was completed with 61 patients; 20, 23 and 18 of whom were in the pulmonary exercise group, the combined exercise group, and the control group, respectively. Four patients (%6.1) were excluded from the study. Two patients excluded from study due to exacerbation of disease. Two patients could not complete the study due to personal reasons. The mean age was 64.9±8.6 (51-83 years); 5 of them were female (8.2%), and 56 of them were male (91.8%). There were no significant demographic differences except PImax value, between the groups ($p> 0.05$). However, PImax levels in the pulmonary rehabilitation group was higher than the other groups ($p< 0.05$) (Table 1). All patients were GOLD 2-3 COPD patients. There were no differences among the groups with respect to disease severity.

The comparison of pre- and post-treatment values among the three groups, revealed that the FEV1, FEV1/FVC, PImax and PEmax levels were significantly higher in the pulmonary rehabilitation and the combined exercise groups, whereas no significant increase was noted in the control group. Also FVC and VC levels were significantly higher in the combined exercise group, whereas no significant increase was noted in the pulmonary rehabilitation and the control group (Table 2).

When pre- and post-treatment levels of the three groups were assessed with respect to ETT, MRC and BODE index; significant difference in ETT scores and MRC scores were found both in the pulmonary rehabilitation and the combined exercise groups, while significant difference in BODE index was noted only in the combined exercise group ($p=0.001$) (Table 3).

Significant difference was found in the pulmonary rehabilitation and the combined exercise groups with respect to the pre- and post-treatment values of physical function, body pain, physical and emotional problems as assessed with SF-36 questionnaire ($p<0.05$). In addition, general health values and the vitality values showed significant differences in the combined exercise group and the pulmonary rehabilitation group, respectively ($p<0.05$) (Table 4).

Based on the quality of life test results assessed with SF–36 before the treatment, no statistically significant difference was found among all three groups ($p>0.05$). No statistical difference was found when the patients were assessed with SGRQ symptom and impact score values before the treatment ($p>0.05$). There was a statistically significant improvement in total and all component scores of SGRQ in pulmonary rehabilitation and combined exercise groups after the treatment ($p<0.05$) (Table 5). There was no change in treatment s or systemic steroid use fot 8 weeks.

Table 1. Characteristic distribution of patients

Variables	Pulmonary Exercise Group (n=20)	Combined Exercise Group (n=23)	Control Group (n=18)	*p**
Age (year)	61.0±8.1	66.7±7.6	67.0±9.1	0.051
Gender (male/female)	17/3	22/1	17/1	0.403
BMI (kg/m^2)	25.7±2.4	27.4±3.9	27.4±3.9	0.310
Smoking (pack/year)	49.5±36.8	50.6±34.0	54.2±47.8	0.968
Period of disease (year)	7.7±3.0	6.8±3.3	5.6±2.3	0.167
FEV_1, % predicted	67.2±21.3	63.9±25.0	67.1±20.4	0.897
FVC, % predicted	86.7±22.8	90.8±23.8	85.0±20.2	0.784
FEV_1/FVC	60.2±15.0	54.4±16.4	60.6±14.6	0.412
PI_{max} (k/pa)	10.4±1.2	10.2±0.8	10.2±0.8	**0.038**
PE_{max}(k/pa)	19.5±2.2	19.2±1.4	19.1±1.6	0.104
ETT (MET)	8.4±2.3	7.7±2.4	7.6±2.7	0.520
MRC dyspnea scale	1.8±0.9	2.0±0.7	2.0±0.7	0.461
BODE	2.8±1.8	3.0±1.6	2.9±1.3	0.804

*p**: Kruskal-Wallis test. Bold values considered statistically significant

Table 2. Pulmonary function tests before and after the treatment

		Before Treatment	After Treatment	*p**
FEV_1, L	Pulmonary Exercise Group	2.1 ± 0.8	2.3 ± 0.9	**0.003**
	Combined Exercise Group	1.9 ± 0.8	2.4 ± 0.8	**0.000**
	Control Group	1.8 ± 0.7	2.0 ± 0.7	0.248
FEV_1, % predicted	Pulmonary Exercise Group	67.2 ± 21.2	66.1 ± 23.7	0.268
	Combined Exercise Group	63.9 ± 25.0	65.7 ± 27.4	0.174
	Control Group	67.1 ± 20.4	66.7 ± 20.0	0.974
FVC, L	Pulmonary Exercise Group	3.4 ± 0.9	3.5 ± 1.0	0.160
	Combined Exercise Group	3.3 ±1.0	3.6 ± 1.0	**0.002**
	Control Group	3.0 ± 0.8	3.1 ± 0.8	0.717
FVC, % predicted	Pulmonary Exercise Group	86.7 ± 22.9	86.7 ± 24.1	0.195
	Combined Exercise Group	90.7 ± 24.0	88.4 ± 28.2	0.493
	Control Group	84.5 ± 20.1	83.2 ± 26.5	0.432
FEV_1/FVC	Pulmonary Exercise Group	60.2 ± 15.0	63.8 ± 16.0	**0.001**
	Combined Exercise Group	54.5 ± 16.3	65.1 ± 15.2	**0.000**
	Control Group	60.5 ± 15.0	62.8 ± 14.0	0.092
VC, L	Pulmonary Exercise Group	3.4 ± 1.5	3.4 ± 1.1	0.056
	Combined Exercise Group	3.3 ± 1.1	3.7 ± 0.1	**0.002**
	Control Group	3.0 ± 0.8	3.1 ± 0.8	0.687
PI_{max} (k/pa)	Pulmonary Exercise Group	10.4 ± 1.2	10.7 ± 1.1	**0.000**
	Combined Exercise Group	10.2 ± 0.8	10.4 ± 1.0	**0.000**
	Control Group	10.1 ± 0.8	15.7 ± 24	0.453
PE_{max} (k/pa)	Pulmonary Exercise Group	19.4 ± 2.2	19.8 ± 2.1	**0.000**
	Combined Exercise Group	19.1 ± 1.4	19.3 ± 2.0	**0.000**
	Control Group	19.1 ± 1.6	19.0 ± 1.7	0.246

*p**: Wilcoxon signed ranks test. Bold values considered statistically significant

Table 3. Before and after treatment MRC, BODE and ETT results

		Before Treatment	After Treatment	*p**
MRC dyspnea scale	Pulmonary Exercise Group	1.8 ± 0.9	1.7 ± 0.9	**0.015**
	Combined Exercise Group	2.0 ± 0.7	1.3 ± 0.8	**0.000**
	Control Group	1.8 ± 0.5	1.7 ± 0.6	0.317
BODE	Pulmonary Exercise Group	2.8 ± 1.8	2.5 ± 1.8	0.058
	Combined Exercise Group	3.0 ± 1.6	2.1 ± 1.7	**0.001**
	Control Group	2.9 ± 1.3	2.7 ± 1.5	0.083
ETT (MET)	Pulmonary Exercise Group	8.4 ± 2.3	9.0 ± 1.5	**0.033**
	Combined Exercise Group	7.7 ± 2.4	9.3 ± 3.7	**0.015**
	Control Group	7.6 ± 2.7	7.5 ± 2.8	0.100

*p**: Wilcoxon signed ranks test. Bold values considered statistically significant

Table 4. Before and after the treatment evaluation of SF-36 quality of life index

SF-36	Before Treatment	After Treatment	*p**
General Health			
Pulmonary Exercise Group	60.0 ± 5.1	58.6 ± 6.5	0.109
Combined Exercise Group	58.9 ± 5.8	56.1 ± 6.0	**0.047**
Control Group	59.7 ± 3.9	60.2 ± 5.0	0.603
Mental Health			
Pulmonary Exercise Group	64.4 ± 8.6	61.0 ± 7.3	0.102
Combined Exercise Group	59.8 ± 8.2	56.2 ± 11.2	0.173
Control Group	61.5 ± 8.6	62.4 ± 5.5	0.526
Vitality			
Pulmonary Exercise Group	51.4 ± 6.9	54.2 ± 6.2	**0.027**
Combined Exercise Group	51.3 ± 5.9	53.9 ± 6.9	0.122
Control Group	50.8 ± 6.9	50.6 ± 5.9	0.968
Physical Function			
Pulmonary Exercise Group	76.4 ± 21.7	90.8 ± 21.0	**0.000**
Combined Exercise Group	66.2 ± 17.7	90.6 ± 16.4	**0.000**
Control Group	64.6 ± 17.5	69.3 ± 17.1	0.082
Social Function			
Pulmonary Exercise Group	24.6 ± 4.1	25.4 ± 3.7	0.396
Combined Exercise Group	25.2 ± 3.7	24.0 ± 2.6	0.090
Control Group	25.1 ± 3.0	24.6 ± 2.4	0.480
Bodily Pain			
Pulmonary Exercise Group	26.6 ± 6.7	20.0 ± 6.8	**0.000**
Combined Exercise Group	24.9 ± 6.5	17.8 ± 5.4	**0.000**
Control Group	28.6 ± 5.3	26.6 ± 6.8	0.109
Physical Limitations			
Pulmonary Exercise Group	16.8 ± 1.6	20.0 ± 3.8	**0.001**
Combined Exercise Group	16.5 ± 1.3	21.3 ± 3.1	**0.000**
Control Group	16.6 ± 1.5	16.8 ± 1.7	0.564
Emotional Limitations			
Pulmonary Exercise Group	12.8 ± 1.6	15.6 ± 3.4	**0.002**
Combined Exercise Group	12.5 ± 1.3	16.5 ± 2.7	**0.000**
Control Group	12.0 ± 0.0	12.4 ± 1.2	0.157

*p**: Wilcoxon signed ranks test. Bold values considered statistically significant

Table 5. Before and after the treatment evaluation of SGRQ

SGRQ	Before Treatment	After Treatment	*p**
Symptom score			
Pulmonary Exercise Group	52.0±18.8	45.1±20.6	**0.010**
Combined Exercise Group	61.8±19.1	47.7±17.4	**0.000**
Control Group	58.8±23.5	58.6±23.8	0.561
Impact score			
Pulmonary Exercise Group	48.9±20.1	39.8±21.7	**0.010**
Combined Exercise Group	60.0±13.1	33.5±17.4	**0.000**
Control Group	55.9±20.5	58.8±23.8	0.100
Activity score			
Pulmonary Exercise Group	57.2±21	51.1±22.8	**0.040**
Combined Exercise Group	75.4±14.3	49.0±20.9	**0.000**
Control Group	70±20.5	67.9±22.9	0.152
Total score			
Pulmonary Exercise Group	48.6±16.1	43.6±16.0	**0.020**
Combined Exercise Group	61.5±14.3	39.7±18.7	**0.000**
Control Group	60.8±18.6	59.0±21.6	0.100

*p**: Wilcoxon signed ranks test. Bold values considered statistically significant

Discussion

This study aimed to investigate the effect of chest physiotherapy and aerobic exercises on pulmonary capacity and the quality of life. We found statistically significant differences between pulmonary exercise, combined exercise and control groups with respect to several parameters. Significant improvements were recorded in the FEV1, FEV1/FVC, PImax and PEmax levels. Also FVC and VC levels were significantly increased in combined exercise group, whereas no significant increase was noted in pulmonary rehabilitation and control group. Significant difference in ETT scores and MRC scores were found both in pulmonary rehabilitation and combined exercise groups.

It is known that pulmonary rehabilitation leads to improvement in parameters such as the quality of life, dyspnea, and functional capacity in patients with COPD. However, its effect on lung functions is known to be limited.[4,12] In our study, a significant increase in FEV1 and FEV1/FVC values were observed both in pulmonary rehabilitation and combined exercise groups. Moreover, increase in FVC and VC levels were observed only in the combined exercise group.

Dysfunction of respiratory muscles is the most important factor causing limitation in exercise. Increasing the force and endurance of the respiratory muscles may improve the exercise tolerance, and decrease dyspnea.[13]

The improvement in dyspnea has an important role in improving the quality of life of COPD patients, and it is one of the main targets of the pulmonary rehabilitation programs.[14] Previous studies have shown that pulmonary rehabilitation leads to a decrease in dyspnea severity of COPD patients.[14,15] In our study significant difference in MRC scores was found both in pulmonary rehabilitation and combined exercise groups.

Another important issue in COPD patients is the impairment of exercise tolerance that may even limit the daily activities. There are few studies evaluating exercise capacity in COPD.[16,17] In a study of Berry et al, an increase in 6-minute walking distance was reported and this increase was more significant in the patients with mild to moderate COPD.[16] Their results showed that 6-minute walking distance was one meter more in mild to moderate group. However Withers et al reported that the exercise performance of patients with severe COPD has also increased after pulmonary rehabilitation.[17] We also found significant increases in both exercise groups after treatment. Approximately 50 cm increase in combined group and 23 cm increase in pulmonary exercise group.

Recently, it was suggested that monitoring of COPD with the airway obstruction parameters is not sufficient and several indices are needed to reveal other dimensions of COPD, due to the fact that COPD is a multidimensional disease. BODE was introduced as a multidimensional grading system in the recent publications on COPD.[4,5] Significant improvements were observed within combined exercise group.

In our study, the pulmonary rehabilitation was shown to have positive effects on majority of the quality of life parameters. SF-36 -a scale for quality of life- has been evaluated in terms of functional condition, well-being, general health understanding, and global quality of life.

Although pulmonary rehabilitation is generally indicated to decrease the anxiety.[18] As anxiety may be affected by various factors such as monetary affairs, dyspnea intensity, other diseases accompanying COPD, support of family members, and functional restrictions; it is clear that expecting the pulmonary rehabilitation to definitely decrease the anxiety will not be realistic.[19]

Previous studies reported significant positive effects of pulmonary rehabilitation on quality of life scores. Dheda et al, have shown that training of COPD patients for issues such as exercise, nutrition, and smoking cessation has lead to significant improvements in SGRQ symptom score.[20] In the study of Garuti et al, the quality of life has been evaluated with SGRQ, and it has been identified that after pulmonary rehabilitation there were statistically significant improvement in quality of life.[19] Stewart et al, have shown that the pulmonary rehabilitation; implemented to the patients who are under treatment at hospital; leads to statistically significant improvement in quality of life.[21] In our study, it was also determined that the significant changes in symptom, activity, impact, and total scores of SGRQ in both exercise groups were determined after tratment.

During the treatment, no patient reported any worsening in their breathing difficulties due to the exercise training. On the other hand, in patients with severe COPD it was necessary to interrupt the treatment for the periods ranging from 2-3 days to 1 week due to the upper and lower respiratory tract infections. In American Thoracic Society statements on pulmonary rehabilitation, lack of motivation and compliance problems were indicated as the most common problems experienced during the implementation of rehabilitation programs. Also it was reported that the problems such as low socio-economic levels, insufficient support from the family, logistic problems (distance, transportation), and financial problems hinder regular participation to the program.[22] These problems, which were also reported in studies carried out in European countries, were experienced in our study as well, and 2 of the patients were excluded from the study because of the aforementioned reasons. It is considered that the socio-economic and cultural structures of the studied regions should be taken into account while determining the duration and intensity of the pulmonary rehabilitation programs.

This study has shown that an addition to the respiratory exercise treatment for 8 weeks to the stable COPD patients who were receiving sufficient medical treatment had positive impacts on the quality of life and exercise capacity. The inclusion of pulmonary rehabilitation into the treatment of patients with moderate to severe COPD, who are treated properly based on severity of disease, has significant effects on pulmonary function, exercise capacity, dyspnea and quality of life. Since COPD is a multidimensional disease, it should be evaluated and treated in many directions way. Thus, besides proper medical treatment, pulmonary rehabilitation programs should be included in the management of COPD patients who are appropriate for such treatment.

Conflict of Interest

There is no conflict of interest.

Compliance of Ethical Statement

Ethical approval for the study was granted by the ethical committee of Kocaeli University Faculty of Medicine (Ethical Committee of Clinical Researches No: 5/22).

Financial Disclosure/Funding

The authors declared that no financial support was received for this paper.

Author Contributions

IS, Mİ, İB, EŞ: Idea/hypothesis; IS, EŞ, Mİ, İB, ÇÇ: Design of study, EŞ, IS, ÇÇ: Data collection; IS, EŞ: Source search; IS, EŞ, ÇÇ, Mİ, İB: Analysis/comment of results; IS, ES, Mİ, İB: Writing; İB: Critical review; IS, İB: Publishing process.

References

1. Vos T, Flaxman AD, Naghavi M et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease study 2010. *Lancet*. 2012;380:2163-2196. doi:10.1016/s0140-6736(12)61690-0
2. Lozano R, Naghavi M, Foreman K, et al. Global and regional mortality from 235 causes of death for 20 ages groups in 1990 and 2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380: 2095-2128.
3. Corhay JL, Dang DN, Cauwenberge HV, et al. Pulmonary Rehabilitation and COPD: providing patients a good environment for optimizing therapy. *Int J Chron Obstruct Pulmon Dis*. 2014;9:27-39. doi:10.2147/copd.s52012
4. Rochester CL, Vogiatzis I, Holland AE, et al. An official American Thoracic Society/European Respiratory Society Policy Statement: Enhancing Implementation, Use, and Delivery of Pulmonary Rehabilitation. *Am J Respir Crit Care Med*. 2015;192:1373-1386. doi: 10.1164/rccm.201510-1966ST
5. Steiner MC, Morgan MDL. Enhancing physical performance in chronic obstructive pulmonary disease. *Thorax*. 2001;56:73-77. doi:10.1136/thorax.56.1.73
6. Janssens W, Corhay JL, Boagerts P, et al. How resources determine pulmonary rehabilitation programs: A survey among Belgian Chest Physicians. *Chron Respir Dis*. 2019;16: 1479972318767732. doi:10.1177/1479972318767732
7. Global Initative For Chronic Obstructive Lung Disease, Global Strategy for the Diagnosis, Management and Prevention of Chronic Obstructice Pulmonary Disease updated 2018 www.goldcopd.org. Accessed October 20, 2019.
8. Bestall JC, Paul EA, Garrod R, et al. Usefulness of the Medical Research Council (MRC) dyspnoea scale as a measure of disability in patients with chronic obstructive pulmonary disease. *Thorax*. 1997; 54(7):581-586. doi:10.1136/thx.54.7.581
9. Ware JE Jr, Snow KK, Kosinski M, et al. SF-36 health survey: manual and interpretation guide. *Boston: The Health Institute, New England Medical Center*; c1993.
10. Ferrer M, Villasante C, Alonse J, et al. Interpretation of quality of life scores the St George's Respiratory Questionnaire. *Eur Respir J*. 2002; 19:405-413. doi: 10.1183/09031936.02.00213202
11. Koblízek V, Salajka F, Cermáková E, et al. Relationship between quality of life and BODE index of stable ex-smokers with chronic obstructive pulmonary disease. *Vnitr Lek*. 2009; 55(10):940-947.
12. An official American Thoracic Society/European Respiratory Society Policy Statement: Enhancing Implementation, Use, and Delivery of Pulmonary Rehabilitation. https://www.thoracic.org/statements/resources/copd/implem-pulm-rehab.pdf. Published 2015. doi:10.1164/rccm.201510-1966st
13. Rochester CL. Exercise training in Chronic Obstructive Pulmonary Disease. *J Rehabil Res. Dev* 2003; 40(5 Supplement 2):59–80. doi:10.1682/jrrd.2003.10.0059
14. Bourjeily G, Rochester CL. Exercise Training in Chronic Obstructive Pulmonary Disease. *Clin Chest Med*. 2000; 21:763-781. doi:10.1016/s0272-5231(05)70183-0

15. Stulbarg MS, Carrieri- Kohlman V, Demir- Deviren S, et al. Exercise Training Improves Outcomes of Dyspnea Self-management Program. *J Cardiopulm Rehabil*. 2002; 22(2):109-121. doi:10.1097/00008483-200203000-00010
16. Berry MJ, Rejeski WJ, Adair NE, Zaccaro D. Exercise Rehabilitation and Chronic Obstructive Pulmonary Disease Stage. *Am J Respir Crit Care Med*. 1999; 160:1248-1253. doi:10.1164/ajrccm.160.4.9901014
17. Withers NJ, Rudkin ST, White RJ. Anxiety and depression in severe Chronic Obstructive Pulmonary Disease: The effects of pulmonary rehabilitation. *J Cardiopulm Rehabil*. 1999; 19(6):362–365. doi:10.1097/00008483-199911000-00007
18. Carrieri-Kohlman V, Gormley JM, Douglas MK, Paul SM, Stulbarg MS. Exercise training decreases dyspnea and the distress and anxiety associated with it. *Chest*. 1996;110(6):1526–1535 doi:10.1378/chest.110.6.1526
19. Garuti G, Cilione C, Dell'orso D, Gorini P, Lorenzi MC, Totaro L, et al. Impact of Comprehensive Pulmonary Rehabilitation on anxiety and depression in hospitalized COPD patients. *Monaldi Arch Chest Dis*. 2003; 59(1):56-61.
20. Dheda K, Crawfard A, Hagan G, Robert C. Implementation of British Thoracic Society Guidelines for Acute Exacerbation of Obstructive Pulmonary Disease: Impact on Quality of Life. *Medical Journal*. 2004; 80(41):169-171. doi:10.1136/pgmj.2003.012831
21. Stewart DG, Drake DF, Robertson C, Marwitz JH, Kreutzer JS, Cifu DX. Benefits of an Inpatient Pulmonary Rehabilitation Program: A Prospective Analysis. *Arch Phys Med Rehabil*. 2001; 82(3):347-352. doi:10.1053/apmr.2001.20838
22. Tucker S, Canobbio M, Paquette E, Wells M. Patients Care Standarts. 7th ed. St Louis: Mosby; 2000. p. 241-250.