Original Article

Effect of 12-week endurance exercise on obese elderly patients with COPD: a randomized trial

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ABSTRACT

Background: Chronic Obstructive pulmonary disease (COPD) is the most common reason for the increasing rates of mortality and morbidity among the elderly population. Different therapeutic modalities are required to improve pulmonary functions and aerobic capacity in COPD patients.Objectives: The aim of this study was to examine the influences of twelve weeks of endurance exercise on respiratory functions and aerobic capacity in obese elderly people with COPD.Design: 40 elderly subjects with moderate COPD were enrolled in this study. Their age ranged from 60 to 70 years and body mass index (BMI) was 30 to more than 40 kg/m^2. Study participants were allocated into 2 groups (endurance exercise and control groups). The endurance exercise group (n=20) received endurance exercise 3 sessions weekly for 12 weeks with traditional medications while control subjects (n=20) conducted traditional medication with no specific exercise program for 12 weeks. Pulmonary functions, 6-minute walk test, and Borg score were assessed pre- and post-intervention program. Results: After completing the 12-week intervention, the findings displayed a significant reduction of BMI and betterment of the pulmonary functions, 6-minute walk test, and Borg dyspnea score in the endurance exercise group ($p<0.05$) while non-significant changes in control subjects ($p>0.05$). Assessing the differences between the two groups displayed significance between the two groups in better turn to the endurance exercise group ($p<0.05$).Conclusions: It was concluded that endurance exercise lowers BMI and increases pulmonary functions and aerobic capacity in obese elderly COPD people. Controlling obesity is directly associated with improving pulmonary functions and aerobic capacity in the elderly with COPD. Endurance exercise should be recommended as an imperative element of respiratory rehabilitation among individuals with respiratory disease, particularly elderly COPD patients.

Keywords: COPD, Obesity, Endurance Exercise, Pulmonary Functions, 6-minute walk test, Dyspnea.

Introduction

Chronic obstructive pulmonary disease (COPD) is one of the chronic diseases that is considered a common cause of mortality.[1] It provides an oppressive load for patients and the community.[2] Pulmonary rehabilitation joining interferences on the pulmonary system (giving up smoking), psychosomatic holding up (coping skills), and exercise training enhances aerobic capacity and life quality and reduces the treatment cost.[3]

Commonly, COPD may cause impairment of body functions, such as muscle weakness and difficulty of breathing (dyspnea). Exercise training is a recommended issue to decrease disabilities, strengthen muscles, and improve quality of life. High-intensity endurance exercise is considered as a type of exercise that can increase functional performance and life quality; however, some subjects are unable to perform this type

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of exercise as they feel improper manifestations such as dyspnea and muscle fatigue.[4]

Many obese patients have respiratory dysfunction; the physiological disorders of obesity affect lung function as reported in previous studies. While the effect of obesity on respiratory disorders is complicated and exceeded mechanical and physical outcomes such as weight and metabolic disorders. Both COPD and obesity are correlated with worsening in pulmonary function and aerobic capacity, which increase morbidity and mortality.[5]

The major problem of COPD and obesity is dyspnea.[6, 7] Recently, retrospective cohort study has indicated that obese individuals with COPD suffer from dyspnea more than normal individuals with COPD.[8]

Early studies have confirmed skeletal muscle dysfunctions as a cause of intensive COPD.[9] Exercise training has been considered as the main component of pulmonary rehabilitation.[10] Various investigations have approved that aerobic exercise relieves COPD combined with skeletal muscles disorders and also it alters the metabolism and morphologies of the skeletal muscles.[11]

Despite good medical management, subjects with moderate COPD frequently feel a functional disorder, which is related to dyspnea, fatigue, and muscle weakness.[12] Physical training has been revealed to be an impressive method of revoking functional deterioration and enhancing the quality of life in older and elderly populations.[13, 14] High-intensity endurance exercise has achieved the most significant improvement in aerobic capacity, muscle strength, and quality of life. In fact, COPD patients cannot perform high-intensity endurance training due to the manifest symptoms of leg fatigue and difficulty breathing (dyspnea).[3, 4]

Previous studies found that aerobic exercise has positive impacts on pulmonary functions in asthmatics[15] and cardiac patients.[16] Also, a previous study concluded the positive effects of endurance exercise in COPD patients while limited documents evaluated the influence of endurance workout program on aerobic capacity and pulmonary functions in elderly obese patients with COPD. Therefore, this trial was designed to ascertain the influence of 12 weeks of endurance workout on the pulmonary functions and aerobic capacity in elderly COPD patients hypothesizing that endurance exercise could improve pulmonary functions and aerobic capacity in those patients.

Subjects and Methods

Subjects

Forty elderly subjects with COPD (moderate, FEV1 = 50-79% predicted) were selected from the department of pulmonary disease for this randomized controlled trial, their age was 60-70 years, and body mass index (BMI) was 30 to more than 40 kg/m^2. Those 40 subjects were randomly divided into the endurance exercise and control groups. Endurance exercise group (n=20) conducted endurance exercise 3 sessions weekly for 12 weeks with traditional medications while the controls (n=20) conducted traditional medication with no specific exercise program. The subjects were excluded from the trial if they had musculoskeletal limitations, life-limiting disorders, and cardiovascular and endocrinal diseases. This trial was ethically approved by the Local Ethics Committee of The Physical Therapy Department, PSAU University [No.:RHPT/016/012].

Sample size calculation

This randomized study required a sample of 16 individuals in each group agreeing to the power of 80% and changes of 20% in the pulmonary functions with the standard deviation of 0.5 and significance level of 5%. Consequently, 40 individuals were included in the study to account for the dropout.

Randomization

From forty-seven, forty subjects were enrolled in this trial. 4 subjects did not meet the inclusion criteria of the trial and 3 subjects refused to participate in the trial. The allocation was carried out before starting the program by a blinded examiner who did not concern the group to which each subject was equipped. Figure 1 clarified the CONSORT flow diagram of the current trial.

Procedures

Assessment

Each subject was assessed for BMI, pulmonary functions (FVC, FEV1, FEV1/FVC) using digital spirometer (CONTEC:SP10,China), aerobic capacity consuming 6-minute walk test before and after the treatment program, and dyspnea score by the same blinded examiner. Each subject signed informed consent before starting the study program and all subjects were notified about the design, principles, and procedures of the trial.

Intervention

In the endurance exercise group, each subject conducted a program of endurance exercise 3 sessions weekly for 12 weeks. The program was consisted of bicycle ergometer and arm crank exercise, the intensity of cycling was started at 30% W_{peak} for ten minutes and was elevated in accordance with recorded symptoms up to 75% W_{peak} for twenty-five minutes for twelve weeks. Arm crank was started with 4-minute, and elevated to 9-minute in the 12th week. The target of the exercise was determined by the Borg scale of 5-6 for dyspnea.[17]

Statistical Analysis

Data were analyzed employing the formula of the mean and standard deviations. Descriptive statistics calculated the alterations of the outcome measures (BMI, FVC, FEV1, FEV1/FVC%, 6-minute walk test, and Borg dyspnea score) utilizing student's *t*-test (unpaired) intergroup whereas paired *t*-test was performed to assess the pre-post differences intragroup. Data were analyzed utilizing SPSS (v.18, Chicago, IL, USA). The significance was set at $p<0.05$.

Results

Baseline and clinical characteristics showed a non-significant difference intergroup in all measures ($p>0.05$) (Table 1). After the 12-week intervention, the findings showed a significant improvement of BMI, pulmonary functions, aerobic capacity, and Borg dyspnea score in the endurance exercise group ($p<0.05$) whereas there were non-significant differences in the controls ($p>0.05$) as presented in Table 2.

As presented in Table 3, Comparison between the two groups showed significant differences intergroup in all outcome measures (BMI, FVC, FEV1, FEV1/FVC %, 6-minute walk test, and Borg dyspnea score) in a better turn to the endurance exercise group at the end of 12th week ($p<0.05$).

Discussion

This randomized trial was proposed to determine the effect of 12 weeks of endurance exercise on the pulmonary functions and aerobic capacity in obese elderly COPD patients hypothesizing that endurance exercise could reduce weight, improve pulmonary functions and aerobic capacity in those patients. The results of the current trial confirmed our hypothesis as well as led to weight reduction, improvement of the pulmonary functions and aerobic capacity, and decreased dyspnea symptoms in obese elderly patients with moderate COPD.

High BMI is accompanying with functional impairment of the respiratory system such as high incidence of asthma, reduction of FEV1 value, sleep disturbance, and risky issues during surgical operations.[18] In COPD patients, the effects of obesity are varied, which include dyspnea, poor life quality, and aerobic capacity.[19]

In accordance with the present study outcomes, lowering of BMI was accompanied by improving pulmonary functions, aerobic capacity, and dyspnea after a 12-week endurance exercise in obese elderly individuals with COPD. Hanson et al supported these outcomes and provided the positive relationship between weight loss and lung functions when studied the effect of diet and obesity on COPD outcomes and its development.[20] In addition, prior research documented that reducing weight has a useful influence in improving the pulmonary function of obese subjects with COPD and asthma.[21]

In agreement with our findings, Khosravi et al. approved that endurance exercise has positive effects on pulmonary functions and no significant difference outcomes on FVC, FEV1, FEV1/FVC% in healthy subjects.[22] Also, Rinaldo et al. showed positive effects of aerobic exercise on COPD patients including improvements in the peripheral muscle strength following endurance exercise.[23] Similarly, Liao et al. demonstrated that in COPD patients, aerobic exercise training that includes all body exercise with particular endurance exercise has positive effects on pulmonary rehabilitation over time.[24]

Previously, some articles reported that pulmonary functions are improved due to the increase of muscle contraction or respiratory muscles strength, particularly expiratory muscles, which result in balancing airway resistance and improvement of lung compliance.[25-27] Various studies provided that the capacities of respiration muscles are enhanced by means of applicable stimulation leading to the improvement of the respiratory muscles' workload. Therefore, exercise training for the respiratory muscles may accelerate cellular and metabolic changes of the trained muscles.[28]

Physiologically, endurance exercise may improve circulation and vasodilatation that result in increased secretions of cortisol and adrenaline. Cortisol works as a bronchodilator and improves the creation of lung surfactant while adrenaline improves circulation and blood flow of the pulmonary vessels and also improves airway property, gas exchange, and blood oxygenation, as well as it lowers airway resistance and increases pulmonary functions.[29]

The clinical implication of the present study was that the 12-week endurance exercise plays a critical role in improving pulmonary functions and aerobic capacity in obese elderly individuals with COPD. Also, It may be recommended that the clinical practice of this type of exercise has to be considered in the management of COPD in obese subjects, particularly elderly people.

Some limitations were found in this study. The primary limitation was the lack of short and long follow-up assessments and the secondary limitation was associated with the difficulty of considering or generalizing the study outcomes because the people under study were actually dissimilar to the preserved people with a usual living. Further research should have short and long follow up periods (6-12 months).

Conclusions

In the current randomized trial, it was concluded that endurance exercise improves pulmonary functions and aerobic capacity in obese elderly patients with COPD. Controlling obesity is directly associated with improving pulmonary functions and aerobic capacity in the elderly with COPD.Endurance exercise should be recommended as an imperative element of respiratory rehabilitation among individuals with respiratory disease particularly elderly COPD patients.

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Declaration of interest

None.

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Table 1. Baseline and clinical characteristics

Variables	Endurance group (n=20)	Control group (n=20)	*P-value*
Sex (Males/Females)	16/4	13/7	0.921
Age (Years)	71.1±1.12	71.5±1.2	0.283
BMI (Kg/m^2)	34.79±3.61	34.62±2.97	0.872
HR (beat/minute)	86±12	87±13	0.802
RR (breaths/m)	24±2.01	23±1.97	0.121
FVC (% predicted)	74.3±5.4	76.2±5.7	0.286
FEV1 (% predicted)	63.4±2.15	64.2±2.32	0.265
FEV1/FVC (%)	3.7±58.8	3.4±57.6	0.292
6-MWT (m)	421.3±108.4	438.6±115.7	0.628
Dyspnea (Borg Scale)	6±2	6.4±2	0.531

BMI: Body mass index; HR: Heart rate; RR: Respiratory rate; FVC: Forced vital capacity; FEV1: Forced expiratory volume in the first second; 6-MWT: 6-minute walk test.

Table 2. Changes of the mean values in the two groups pre- and post-intervention

Variables	Endurance group (n=20)			Control group (n=20)		
	Pre-	Post-	*P-value*	Pre-	Post-	*P-value*
BMI (Kg/m^2)	34.79±3.61	32.58±2.9	0.039	34.62±2.97	34.68±3.11	0.951
FVC (% predicted)	74.3±5.4	85.6±7.2	<0.001	76.2±5.7	77.4±5.9	0.499
FEV1 (% predicted)	63.4±2.15	78.3±2.6	<0.001	64.2±2.32	64.7±2.41	0.508
FEV1/FVC (%)	3.7±58.8	71.2±4.2	<0.001	3.4±57.6	59.3±5.2	0.229
6-MWT (m)	421.3±108.4	493.6±98.7	0.034	438.6±115.7	441.3±113.2	0.941
Dyspnea (Borg Scale)	6±2	3±1	<0.001	6.4±2	6.1±1.9	0.629

FVC: Forced vital capacity; FEV1: Forced expiratory volume in the first second; 6-MWT: 6-minute walk test.

Table 3. Differences of the mean values between the two groups at the end of the study intervention

Variables	Endurance group (n=20)	Control group (n=20)	*P-value*
BMI (Kg/m^2)	32.58±2.9	34.68±3.11	0.0333
FVC (% predicted)	85.6±7.2	77.4±5.9	0.0003
FEV1 (% predicted)	78.3±2.6	64.7±2.41	<0.0001
FEV1/FVC (%)	71.2±4.2	59.3±5.2	<0.0001
6-MWT (m)	493.6±98.7	441.3±113.2	0.0127
Dyspnea (Borg Scale)	3±1	6.1±1.9	<0.0001

FVC: Forced vital capacity; FEV1: Forced expiratory volume in the first second; 6-MWT: 6-minute walk test.

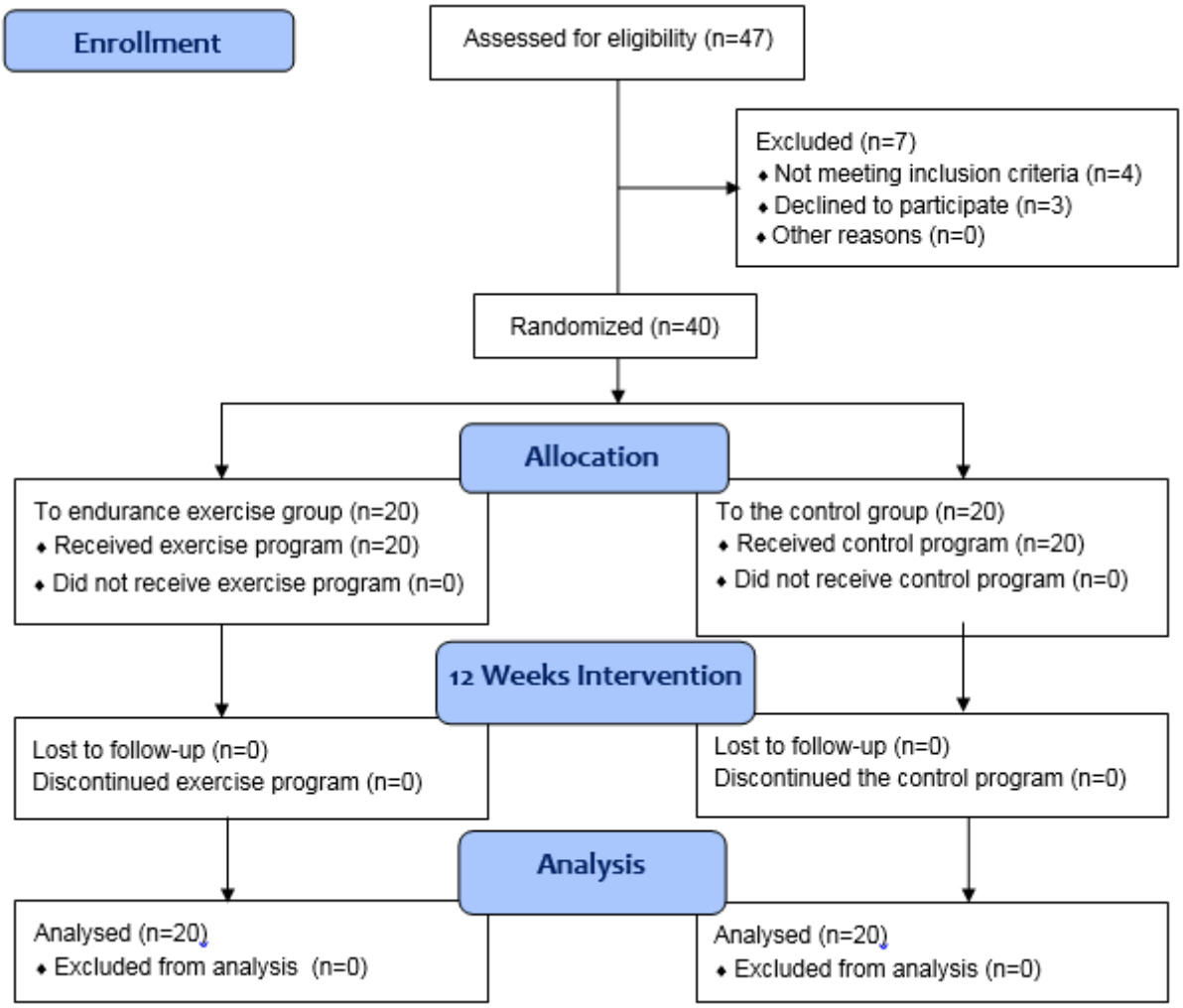

Figure 1: CONSORT flow diagram of the trial