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Original Article

Efficacy of aerobic training on pulmonary functions and depression in elderly COPD patients

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ABSTRACT

Background: COPD in the elderly population is usually associated with depression that decreases quality of life and increases mortality. The main aim of the study was to assess the therapeutic effects of low to moderate-intensity aerobic training on pulmonary functions and depression levels in elderly moderate COPD patients. Methods: This randomized controlled study included thirty-four elderly moderate COPD patients with mild to moderate depression status, their age was ≥ 65 years. The patients were divided into the study and control groups randomly. The study group (n=17) conducted a low to moderate-intensity aerobic training, three times/week for twelve weeks while the control group (n=17) did not conduct any exercise training. Before and after the study intervention, pulmonary functions and depression scores were assessed. Results: Baseline characteristics presented a non-significant difference between the study and control groups ($p>0.05$). A significant improvement in pulmonary functions and depression score was observed in the study group after finishing the study program ($p<0.05$) while non-significant changes were shown in the control group. The findings showed significant differences between groups in pulmonary functions and depression scores in favor of the study group ($p<0.05$). Conclusions: Low to moderate-intensity aerobic training improves pulmonary function and reduces depression in elderly COPD patients.

Keywords:COPD, aerobic training, depression status, pulmonary functions

Introduction

Chronic obstructive pulmonary disease (COPD) considers a preventable and treatable common pulmonary disease characterizing by progressively persistent airflow obstruction affecting the bronchopulmonary system.[1-3] The progressive course of COPD is associated with many complications such as cardiovascular problems, impairment of skeletal muscle function, and depression that result in deterioration of quality of life reduced exercise capacity, and an increase in mortality.[4]

Physical therapy increases exercise capacity and mobility in daily activities, decreases dyspnea, and improves quality of life by applying various therapeutic modalities.[5, 6] Decreased exercise capacity in COPD during stable and exacerbation periods increases the mortality rate accompanied by weakness of the respiratory muscles that affect the lung functions and decreases muscle mass resulting from the breakdown of muscle proteins and atrophy of skeletal muscles.[7] The spreading rate of COPD has increased throughout the past 30 years. COPD is considered the fourth common cause of death worldwide with a rate of 5.1% and it has been predicted that it will be the seventh common cause of disability in 2030. There is an increase in the economic and social burden of COPD.[8]Symptoms of COPD including productive cough and progressive exertional dyspnea lead to activity restriction and finally the inability to work efficiently.[9]

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COPD can be examined by different methods such as spirometer and the COPD assessment test that determine the airflow limitation severity through the forced expiratory volume in one second (FEV1) expressed as a percentage of the normal according to the person's age, gender, height, and weight as FEV1≥80 is mild, FEV1=50–79 is moderate, FEV1=30–49 is severe, and FEV1≤30 is very severe.[10]Inpatient, outpatient, younger, and elderly COPD patients usually suffer from depression ranging from depressive symptoms for short-term to dysthymia up to major depression.[11]

The COPD patients are related to depression commonly depending on the people surveyed and the assessment tools. There was an overlapping between COPD symptoms and depression symptoms that participate in the prevalence rate variations.[12] Several studies approved that outpatients with COPD have depression rates varying from 7% to 80%.[13] Also, in stable COPD patients, the range of depression rate is 10%-42%.The comorbid psychological problems in COPD patients may result in a higher functional impairment, disability, morbidity, and lower quality of life.[14]

Recently, several studies suggest that congenital factors, environmental factors including smoking and inflammation, the severity of symptoms, and lowering quality of life are considered the strongest indicators of depression among COPD patients[15] that affect the adherence to the treatment [16], increase the risk of hospitalization, double the duration of hospitalization, and increase mortality rates. Therefore, there is recently a focus on how to assess and treatpersisting depressive symptoms in COPD patients.[17]

The treatment of COPD includes combined several modalities such as pulmonary rehabilitation therapy as an independent treatment approach of the disease, cognitive behavioral therapy, anti-depressive interventions, pharmacological treatment, psychological interventions, psychotherapy, group therapy, health education, counseling, behavioral interventions, yoga, Tai Chi, relaxation therapy, and alternative modalities.[18-20]

It has been approved that aerobic training has a positive influence on COPD patients but few studies have been conducted to determine the effect of low to moderate-intensity aerobic training on pulmonary functions and depression status and in elderly patients with moderate COPD. Based on that, the hypothesis of the current study was that low to moderate-intensity aerobic training could be beneficial in improving pulmonary functions and depression status in elderly patients with moderate COPD. The main goal of the current study was to assess the therapeutic effects of low to moderate-intensity aerobic training on pulmonary functions and depression levels in elderly moderate COPD patients.

Subjects and Methods

Subjects

Thirty-nine elderly patients with moderate COPD (FEV1= 50–79% predicted) and mild to moderate depression and age of more than 65 years participated in the study from January to May 2019. Each patient was medically stable. All participants were medically diagnosed with depression in accordance with a valid patient-health questionnaire-9 (PHQ-9) regarding the clinical characteristics of depression status. Each participant referred to physiotherapy and outpatient rehabilitation according tohis/her chest physicians and psychiatrists of the tertiary hospital. The participant was excluded from the study if he/she suffered from severe depression, orthopedic complications, neurological dysfunctions, and sever life-limiting illness.

Ethical approval

The study design was a randomized controlled study. The study protocol was ethically approved by the local ethics committee of the Physical Therapy Department, Cairo University Hospitals and complied with the Declaration of Helsinki. Each patient signed written informed consent before participating in the study program.

Sample size and randomization

Thirty-nine participants were enrolled in the study in accordance with resources' availability rather than power and sample size calculation. Of the thirty-nine participants, thirty-four completed this study, two did not encounter the inclusion criteria of the study, and three declined to conduct the study program. The assignment was performed by the blinded physiotherapist before starting the study program. To avoid type II error, the 34 participants were randomly divided into 2 equal groups (n=17) using the table of random digits. The first group (10 males and 7 females) was recruited in the low to moderate-intensity aerobic training (study group) three sessions weekly for 12 weeks while the second group (9 males and 8 females) was not recruited in any exercise intervention (control group). The flow chart of the study is described in Figure 1.

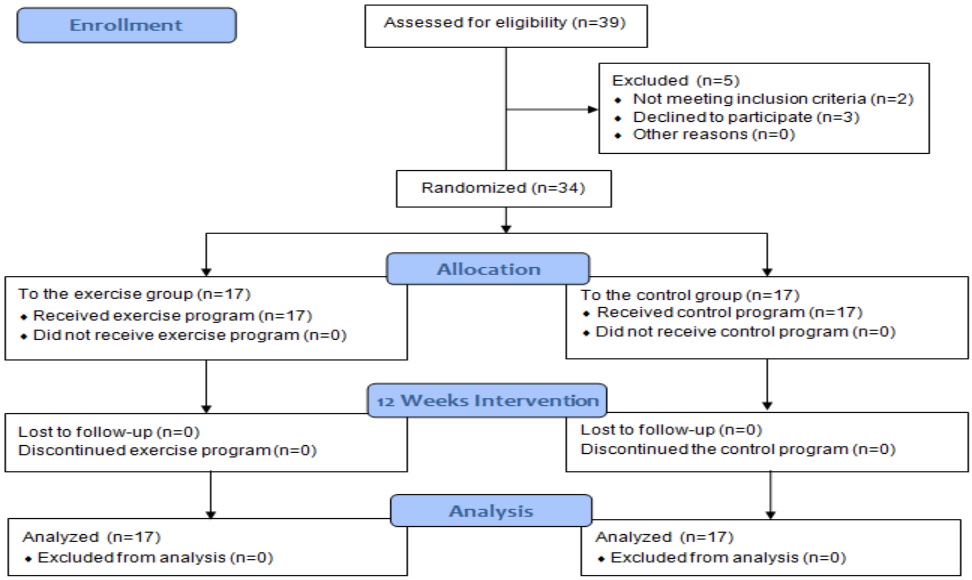

Figure 1: Flow chart of the study

Procedures of the study

Evaluation

All participants of the study were evaluated for the depression scores consuming a valid PHQ-9 and the pulmonary functions (FVC and FEV1) using a digital spirometer (CONTEC: SP10, China) before and after completing the study program (after 12-week intervention) by the same blinded physiotherapist. The validated PHQ-9 was consumed to evaluate the depression scores.[21] The PHQ-9 scale identifies the depression level (mild=5-9, moderate=10-19, and severe≥ 20).

12-week intervention

The participants of the 2 groups were recommended to be active and behave a home-based exercise and have their medical descriptions regularly. The study group received an exercise program of low to moderate-intensity aerobic training, three sessions weekly for twelve weeks. Before starting the exercise program, the maximal heart rate (HR_{max}) was recorded. Each exercise session was commenced with warming up (5-10 min) and finished with cooling down (5-10 min). The twelve weeks of the study were started with the initial 6 weeks of low-intensity aerobic training and ended with 6 weeks of moderate-intensity aerobic training. The low-intensity aerobic was performed conducting the treadmill exercise with 40-50% HR_{max} for 20 to 30 min, 3 times/week while the moderate-intensity aerobics was performed conducting the treadmill exercise 50-70% $HR_{max}$for 30 to 40 min, 3 times/week.

Statistical Analysis

Data were demonstrated and analyzed in the form of means±SD. The descriptive analysis measured the differences in the mean values of FVC, FEV1, and PHQ-9 between the two study groups using unpaired t-test while the changes intragroup were assessed using the paired t-test. Statistical analysis was performed using SPSS software (SPSS v.20, Chicago, IL, USA). Significance was set at $p<0.05$.

Results

As demonstrated in Table 1, baseline characteristics presented non-significant differences between the two study groups in gender, age, body mass index (BMI), FVC, FEV1, and PHQ-9 ($p>0.05$).

Table 1. Baseline characteristics of the participants

Measures	SG (n=17)	CG (n=17)	*p-value*
Gender (M/F)	10/7	9/8	0.920
Age (Years)	69.5±4.23	69.8±4.51	0.843
BMI (Kg/m^2)	26.33±3.72	27.21±3.84	0.502
RR (breaths/m)	21.2±3.2	19.8±3.6	0.239
HR (beat/minute)	102.4±23.5	105.3±24.2	0.725
FVC (% predicted)	72.7±6.4	71.3±6.8	0.541
FEV1 (% predicted)	61.8±4.72	62.4±4.23	0.699
PHQ-9	15.73±3.25	14.88 ±2.86	0.424

SG: Study Group; CG: Control Group; BMI: Body Mass Index; RR: Respiratory Rate; HR: Heart Rate; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume in the first second; PHQ-9: Patient Health Questionnaire-9.

After completing the study program, there was the significant improvement of FVC, FEV1, and PHQ-9 in the exercise group ($p<0.05$) while the control group exhibited non-significant changes in the outcome measures ($p>0.05$) as shown in Table 2.

Table 2. Changes of mean values within each group before and after the intervention

Measures	SG (n=17)			CG (n=17)		
	Before	After	*p-value*	Before	After	*p-value*
FVC (% predicted)	72.7±6.4	83.2±5.31	<0.0001	71.3±6.8	73.5±6.6	0.345
FEV1 (% predicted)	61.8±4.72	76.2±3.45	<0.0001	62.4±4.23	63.9±4.62	0.331
PHQ-9	15.73±3.25	7.43±2.11	<0.0001	14.88 ±2.86	13.7±2.91	0.242

SG: Study Group; CG: Control Group; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume in the first second; PHQ-9: Patient Health Questionnaire-9.

Comparing the study group (Low to moderate-intensity exercise) to the control group, the findings demonstrated significant differences between the two study groups in all mean values of FVC, FEV1, and PHQ-9) in favor of the study group at the end of the study program ($p<0.05$) as shown in Table 3.

Table 3. Differences between groups after intervention

Measures	SG (n=17)	CG (n=17)	*p-value*
FVC (% predicted)	83.2±5.31	73.5±6.6	<0.0001
FEV1 (% predicted)	76.2±3.45	63.9±4.62	<0.0001
PHQ-9	7.43±2.11	13.7±2.91	<0.0001

SG: Study Group; CG: Control Group; FVC: Forced Vital Capacity; FEV1: Forced Expiratory Volume in the first second; PHQ-9: Patient Health Questionnaire-9.

Discussion

The present study was conducted to evaluate the effect of low to moderate-intensity aerobic training on depression status and pulmonary functions in elderly patients with moderate COPD. They were randomly divided into 2 equal groups; each group consisted of seventeen patients. The study group conducted the low to moderate-intensity aerobic training and the control group did not conduct any exercise program. Regular aerobic exercise training is essential for general health well-being and psychological illness and many studies approved safe and beneficial findings[22-24], although many investigations did not encourage these results.[25,26] Previous studies compared the effects of low to moderate-intensity with moderate-intensity continuous exercises on the depressive state in patients with heart failure and found that both exercise programs had significant and beneficialeffects on reducing depression status in patients with heart failure with no differences between them.[27] Several studies approved that aerobic exercises have effective results in decreasing depression illness and major symptoms ofdepressive disorder.[23,24,27] Other investigations confirmed the secretion of dopamine, norepinephrine, endorphins, and serotonin with aerobic training contradicting the effects of depressive disorders, [28] which confirmed that aerobic training has a positive effect on depressed subjects in controlling stress, independence, self-confidence, and normal mental state. The current study confirmed that low to moderate-intensity aerobic training is safe, reliable, and endorsed the role of physiotherapy in controlling depression in elderly COPD patients. The results of this study were supported by Dunn et al., who approved that ten days of walking exercises (30 minutes daily) achieved the optimum decreasing in the major depression disorder depressed individuals using a depressive rate scale.[29]

In agreement with the present study results, another study approved that endurance training for the short-term results in an extreme reduction of depression disorders than anti-depressive drugs in cases with depression.[30] Similarly, the study conducted by Knubbenet al. approved that in people with coronary artery disease,supervised aerobic training leads to positive effects on the functional capacity and reduction of depression manifestations more than home-based aerobic training.[31]

The present study was protocoled to assess the pulmonary functions, exercise tolerance, and psychological parameters and its relevance with COPD. Patients with COPD demonstrated decreased pulmonary function and low exercise tolerance. This study approved significant correlations between aerobic exercises and pulmonary functions. Severe COPD (FEV1< 50%) can cause a considerable decrease in walk capacity.[32,33] Previous research approved that pulmonary functions are usually disturbed in COPD patients[34] explaining why the COPD patients are fatigued and inactive, which considered exercise training as a useful modality for improving pulmonary functions and physical performance.[35] In agreement with the results of this study, previous studies confirmed a significant relationship between aerobic training capacity and pulmonary functions. Consequently, decreased exercise capacity considered an important factor in severity in COPD.[36,37]

On the other hand, the results of this study were contradicted byYohannes, who approved the low benefits of exercise in COPD patients. The pathological deteriorations that occur in the lung could be related to the lack of physical activity and negative impacts of self-confidence leading to not regularly perform aerobic training.[38]

Similarly, various investigations have confirmed improvement in the psychological aspects of people with COPD when performing aerobic training within the limit of moderate sensation.[39,40] Comparing the pre- and post-exercise values showed positive changes in COPD patients treated with a low-intensity exercise program.[41]

After a multidisciplinary pulmonary rehabilitation program, performed by Güell et al., no statistically significant increases were observed in the FVC and FEV1. This result was contributed to the increase in respiratory muscle strength but the lack of change in respiratory functions. Additionally, there were non-significant changes in the arterial blood gases (ABG) values of the patients and a statistically significant increase in the respiratory functions of the FEV1 value (from 60.4 to 70.6), FEV1/FVC ratio (from 56.2 to 62.5), and FEF 25–75 value (from 29.4 to 35.5).[42]

In addition to improvement in the musculoskeletal system at the end of the exercise, studies have shown improvement in pulmonary functions. In the study conducted by Donaire-Gonzalez et al., it was observed that low-intensity exercise decreases hospitalization and mortality rate and improves pulmonary functions and functional capacity.[7]Moreover, a recent study concluded that aerobic exercise improves pulmonary functions, aerobic capacity, and quality of life in asthmatics.[43]

Some limitations were appointed in the present study including missing depression drugs for participants of the study. Besides, exercise compliance with medications, the expenditure of energy, and physical fitness were not assessed to achieve the optimum evaluation of exercise intensity. Further proposals are necessitated to investigate the effect of various durations and intensities of exercise on pulmonary functions and depression state in elderly COPD patients.

Conclusions

It was concluded that low to moderate-intensity aerobics has beneficial effects on improving pulmonary function and reducing the level of depression in elderly COPD patients. Approximately, this type of exercise program has been prescribed among depressed subjects particularly elderly patients with moderate COPD.

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No funds were received for this study.

Competing interests

No competing interests to disclose.

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