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ORIGINAL ARTICLE

BENEFITS OF UPPER-EXTREMITY STRENGTH WORKOUT ON MUSCLE AND FAT-FREE MASS THROUGH HOME-BASED LUNG REHABILITATION IN COPD PATIENTS

A. H. Tarigan[1], A. P. Tarigan[2], P. Pandia[2], P. C. Eyanoer[3]

[1]Department of Pulmonology and Respiratory Medicine, Adam Malik General Hospital, Faculty of Medicine, Universitas Sumatera Utara, Medan, North Sumatera, Indonesia
[2]Asthma-COPD Division, Department of Pulmonology and Respiratory Medicine, Universitas Sumatera Utara Hospital, Faculty of Medicine, Universitas Sumatera Utara, Medan, North Sumatera, Indonesia
[3]Department of Community and Preventive Medicine, Faculty of Medicine, Universitas Sumatera Utara, Medan, North Sumatera, Indonesia

Abstract. Background: *COPD patients not only experience respiratory problems but can have fatigue, physical limitations and reduced overall quality of life. Pulmonary rehabilitation is the main non-pharmacological solution after pharmacological treatment based on COPD grouping. The main aim of this study is to evaluate the benefits of weight lifting strength training twice a week for 4 weeks for COPD patients using home-based pulmonary rehabilitation. It can be done independently by the patient, is easy to do anywhere and at any time and is free of cost. This can be one of the home-based pulmonary rehabilitation options that can be implemented in the future.* ***Methods:*** *This research was a quasi-experimental study with 10 stable COPD patients. The patients underwent home pulmonary rehabilitation of twice-a-week weight-lifting strength exercises for 4 weeks. They were taught how to do the exercise during the initial visit at the hospital which they continued to do independently at home with the help of an instruction video containing the exercise movements. Muscle and fat-free mass measuring was conducted before and after the intervention. Patients were evaluated using videos which they sent to the researchers.* ***Results:*** *COPD patients who concluded the home-based lung rehabilitation showed increase in muscle mass after the intervention (30.12 ± 3.83 SD, p = 0.017). Fat-free mass did not show any increase (49.13 ± 6.93 SD, p = 0.154).* ***Conclusion:*** *Home pulmonary rehabilitation benefits patients as much as the traditional rehabilitation done at health-care centers. This was proven by the significant increase in muscle mass after the intervention despite no change found in fat-free mass, which could be remedied in the future by giving extra diet to meet patients' nutrition needs.*

Key words: *COPD, upper-extremity strength workout, home-based pulmonary rehabilitation, muscle mass, fat free mass*

Corresponding author: *Amira Permatasari Tarigan, Asthma-COPD Division, Department of Pulmonology and Respiratory Medicine, Universitas Sumatera Utara Hospital, Faculty of Medicine, Universitas Sumatera Utara, Medan, North Sumatera, Indonesia. Tel. +6281221211941, Fax: +628211045. e-mail: amira@usu.ac.id*

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INTRODUCTION

The number of COPD cases rises with age [1] and currently is the third cause of death in the world [2, 3]. COPD is preventable and treatable; it is marked by obstructed air flow and restricted breathing passage that causes permanent breathing problems due to abnormal respiratory passage and/or alveolus [4, 5]. The issue with this disease is that not only it affects the lungs, but also has systemic manifestations [6].

Muscle mass loss or atrophy, especially in the lower limbs, is usually associated with impaired function of those muscles in COPD patients. Dysfunction of leg muscles is a systemic consequence of COPD [7] characterized by Type I degradation of muscle fiber proportion, oxidative capacity, smaller muscle cross-sectional area, strength and endurance [8]. Another study also showed that peripheral muscle weakness influenced COPD patients' intolerance to physical activities [9].

Lung rehabilitation program as a non-pharmacological intervention treatment has high potential and is recommended for COPD patients [10-12]. Pulmonary rehabilitation has been shown to increase capacity of exercise, reduce exertion/breathing problems, lower the frequency of relapse and hospital visits, enhancing quality of life and prolonging life expectancy [10, 11, 13, 14].

However, there are some obstacles faced by COPD patients to make a routine visit to hospitals/health centers for lung rehabilitation, such as the journey to reach the health center, transportation problem, patient's disease with/without comorbidity, insufficient human resources and the program's unavailability especially in remote areas [15].

Therefore, the researchers were interested in evaluating the benefits of home-based pulmonary rehabilitation, using the same exercises as the program offered at health centers.

MATERIALS AND METHODS

Study Design

This experiment used a quasi-experimental design by evaluating pre-test and post-test groups, before and after the intervention. Fat-Free Mass Calculator and Omron Karada Scale were used to calculate fat-free mass (FFM) and muscle mass, respectively [16]. This study was conducted at the Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara on July 2020 and was approved by Ethical Committee of Faculty of Medicine Sumatra Utara (No.255/TGL/KEPK FK USU-RSUP HAM/2020).

Inclusion and Exclusion Criteria of Respondents

Inclusion Criteria:

- Stable COPD patients (FEV1/FVC < 70%) who willingly participated in the study and signed the letter of agreement/consent;
- Age 40-70 years old;
- Mild – severe symptoms (mMRC 1-3);
- Receiving therapy according to policlinic group A-D;
- Willing to participate in all procedures of the research and signed the informed consent.

Exclusion Criteria:

- COPD patients with malignancy;
- COPD patients with acute cardiovascular disorder such as acute coronary syndrome or chronic heart failure;
- COPD patients with severe neuromuscular and musculoskeletal disorder, e.g., stroke and severe osteoarthritis;
- COPD patients with current acute infection and sepsis;
- COPD patients who did not adhere to the intervention program.

The Home Exercise Program/Intervention

Prior to the start of the home pulmonary rehabilitation program, respondents had understood and signed the informed consent after receiving oral explanation.

Respondents were taught once at the hospital and then continued the training independently at home, guided by an instruction video. Respondents recorded their home workout sessions and then sent the video to the researchers for evaluation of the exercise movement and obedience.

The following are the procedures of upper body strength workout given to the respondents:

1. Before starting, respondents received/inhaled fast-acting bronchodilator such as 2.5 mg salbutamol.
2. Respondents did a light warm-up and stretching for 5-10 minutes to prevent muscle injury.
3. Training by lifting a bottle of 600 mL of water (weigh more or less 0.5 kg).
4. First and second week of training with the intensity of 5 repetitions (for each movement); third

and fourth week with 10 repetitions (per each movement); the weight lifted remained 0.5 kg.

5. The training session consisted of 3 patterns of movement (a short break of 2-3 minutes were given after each pattern of power exercise before moving to the next one) [17, 18]:

a. Exercise I: Arms crossing on the lap, elbows straight and palms facing downward. Raise arms upward until they are above the head with palms facing backward, and then lower them back to initial position.

b. Exercise II: Arms down, elbows straight, palms facing backward. Raise arms upward while facing outward, over the head and then lower them back to original position.

c. Arms downward, elbows straight, palms facing backward. Raise arms up, facing outward to a horizontal position, and bring both hands together in front in the middle, and then return to the original position.

6. After the session was over patients received another nebulization therapy of 2.5 mg salbutamol.

Statistical Analysis

The data collected were processed using a statistical software application version 23. Univariate analysis was used to determine the value of Mean and Standard Deviation before and after the intervention. The analysis continued with Bivariate Analysis to compare the before and after intervention. The resulting data were tested for normality by Shapiro Wills Test. If the results were normally distributed, then a paired-t Test would be used; but if the opposite occurred, then Wilcoxon Test would be used.

RESULTS

A total of 10 respondents joined the experiment intervention program until the end. Table 1 shows the characteristics of those respondents. The largest age group was age 60-69 years (70%) with all of them being male (100%). The majority of respondents were smokers (90%) with Brinkman Index: Heavy (50%). Most of the respondents were in the mMRC 0-1 (70%) in the exertion scale and Moderate Dyspnea in the Borg scale (30%). The degree of COPD severity was 10 (80%) (Table 1).

Table 2 shows a significant result in muscle mass post intervention (30.12 ± 3.83 SD, p = 0.017). On the other hand, fat-free mass did not show any increase (49.13 ± 6.93 SD, p = 0.154).

Table 1. Characteristics of Respondents

Characteristics	N	%
Age Group (Years)		
50-59	2	10.0
60-69	6	70.0
> 69	2	20.0
Gender		
Male	10	100.0
Height		
< 160	4	70.0
> 160	6	30.0
Smoking Status		
Smoker	9	90.0
Non-smoker	1	10.0
Degree of Brinkman Index		
Mild	2	10.0
Moderate	1	30.0
Severe	6	50.0
Non-smoking	1	10.0
Cigarettes Consumption (cigarette stick/day)		
< 20	3	30.0
20-30	3	20.0
> 30	3	40.0
None	1	10.0
CAT Score (Pre)		
<10	2	20.0
≥10	8	80.0
MMRC Score (Pre)		
0-1	3	70.0
≥ 2	7	30.0
BORG Score (Pre)		
Extremely mild dyspnea	1	10.0
Very Mild dyspnea	1	10.0
Mild dyspnea	1	10.0
Moderate dyspnea	3	30.0
Slightly severe dyspnea	3	20.0
Severe dyspnea	1	20.0

Table 2. Results of Intervention

Variable of Intervention	Mean SD		P
	Pre Intervention	Post Intervention	
Muscle Mass	27.32 ± 4.33	30.12 ± 3.83	0.017
Fat Free Mass	49.41 ± 7.01	49.13 ± 6.93	0.154

Data was presented in Mean SD. p-value from paired T-test, considered significant if $p < 0.05$

DISCUSSION

It has been mentioned in several other publications that pulmonary rehabilitation is effective in reducing the level of exertion, coughing, exacerbation, fatigue, improving exercise tolerance and patient's quality of life [19].

We highly recommend COPD patients participate in home pulmonary program for it has many positive effects and does not need access to health-care institutions, nor an expensive fee to run the program.

Home-based pulmonary rehabilitation yields the same benefits as health-care rehabilitation programs [20].

In a study by I. Vogiatzis et al., they did a lung rehabilitation intervention on COPD patients with cachexia and without cachexia for 10 weeks through the use of high-intensity cycling training. The results showed an increase in the average cross sectional area of muscle fibers in both groups [12]. Tarigan et al. also conducted a home rehabilitation program involving stable COPD patients doing upper-body and breathing exercises twice a week for 4 weeks during Covid-19 pandemic; the muscle mass increased significantly [21]. These findings were in agreement with our results that also revealed a significant increase in muscle mass.

It is common knowledge that weight loss and lower fat-free mass are the most frequent problems occurring in COPD patients [22, 23]. We conducted the intervention to evaluate the impact of the lung rehabilitation on COPD patients fat-free mass. Unfortunately, there was no improvement at the end of the program.

M. Emtner et al. conducted a physical training by using cycle ergometer for 4 weeks supported by additional nutritions during the program and the patients' fat free mass was found to have increased [23]. In another study, patients were given resistance training and protein intake for 12 weeks, and there was a significant result of increased fat-free protein [24].

CONCLUSIONS

Pulmonary rehabilitation is a non-pharmacological treatment highly recommended for COPD patients. Without the trips to hospitals/health care centers, home pulmonary rehabilitation gives a positive impact for COPD patients who may have difficulties in terms of access, transportation, expenses, time, and human resource to produce significant increase in muscle mass. The main aim of this study was to evaluate the benefits of weight lifting strength training twice a week for 4 weeks for COPD patients using the home rehabilitation method. The results showed that there were significant gains for muscle mass but no increase in fat-free mass. Future reference supplementary diet may be necessary for COPD patients.

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Contribution: *AHT & APT conceived and designed the study, conducted research, provided research materials, and collected and organized data. AHT, APT, PP, PCE analyzed and interpreted data. AHT wrote the initial and final draft of the article and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.*

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Availability of data and materials: *All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available from the corresponding author upon reasonable request. The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.*

Ethics Approval and Consent to Participate: *Ethics approval was approved by Ethical Committee of Faculty of Medicine Sumatra Utara (No.255/TGL/KEPK FK USU-RSUP HAM/2020).*

Informed consent: *Written informed consent was obtained from a legally authorized representative for anonymized patient information to be published in this article. The manuscript does not contain any individual person's data in any form.*

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