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The Effectiveness of Home-Based Upper Arm Endurance and Strength Exercises with Egg-white Supplementations on Quality of Life in Stable Chronic Obstructive Pulmonary Disease Patients

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Abstract: ***Because of the limitation of exercise tolerance, the patients tend to adopt and limit those kinds of activities, leading to a decrease in their quality of life. Endurance and strength training was now considered a therapy modality to alleviate several symptoms experienced by Chronic Obstructive Pulmonary Disease (COPD) patients. Further, nutrition management as part of the comprehensive treatment of COPD gives an additional impact on improving functional capacity and quality of life in COPD patients. This study aimed to assess the impact of endurance and strength exercise with egg-white supplementation on the quality of life in COPD patients. This was an experimental study with a total of 22 subjects with a consecutive sampling method; 11 participants in the endurance group, and 11 participants in the strength group. Patients were given strength and endurance training with 28 egg-white supplementations each week for 4 weeks. Quality of life was measured byCOPDAssessment Test (CAT).A total of 22 participants were involved in this study. The majority of the subjects were male, smokers with severe Brinkmann Index, and the age was in the range of 60-69 years old. After four weeks of a training session with egg-white supplementations, we can see there was decreases in CAT score (23.81 to 15.72) with a p-value ≤ 0.05 in endurance training. We also found a significant impact decrease in CAT score (21.72 to 15.63) with a p-value ≤ 0.05 in strength training. Both endurance and strength training with egg-white supplementation can improve the quality of life in stable COPD patients.***

Keywords: Chronic obstructive pulmonary disease, Egg-white supplementations, Pulmonary rehabilitation

1. Introduction

Limitations of activity are a major complaint in COPD patients that will affect their quality of life. Systemic manifestations including a reduction in structural and functional skeletal muscle and a decrease in cardiovascular functions cause the patients to tend to reduce their activities to avoid fatigue and shortness of breath. This is called deconditioning syndrome. Further, the late manifestation of this syndrome is the change in the structure of skeletal muscle and respiratory muscle that will significantly affect the exercise capacity and quality of life in COPD patients [1].

Many studies are just concerned with lower body training to decrease impact in COPD patients, and there are just a few studies that are concerned mainly with upper limb training. However, upper limb training can improve lung function and functional capacity, then reduce symptoms and improve quality of life in patients with COPD.[2–4]Upper limb training is composed of endurance and strength training. The combinations of these types of training showed a significant increase in quality of life in COPD patients. [2,5]

Further, pulmonary rehabilitation also had nutrition support as part of comprehensive treatment for COPD. If the calorie intake is reduced, the body will break down the protein contained in the respiratory muscles[6]. The loss of lean body mass in each muscle will impact the skeletal muscle and respiratory muscle. So, the state of malnutrition will exacerbate COPD conditions because it will reduce respiratory muscle mass[7]. Egg are a food that has a high protein content. Behind the albumin in egg (ovalbumin) is mostly found in the egg white than the yolk. Chicken egg white every 100 grams contain an average of 10.5 grams of protein, 95% of which is albumin[8].

The exercise technique in this study is adopted in some pulmonary rehabilitation programs. However, there was no definite pattern of upper limb training with breathing manoeuver pattern has been conducted with egg-white supplementation. It gives a challenge to pulmonologists concerned in pulmonary rehabilitation to modify some upper limb training to get a positive impact on stable COPD patients. The purpose of this paper is to examine the impact of this modified upper limb training on the quality of life in patients with stable COPD with egg-white supplementation.

2. Methods

This research was an experimental study held in the Department of Pulmonology and Respiratory Medicine, Faculty of Medicine, Universitas Sumatera Utara in 2020.

This study protocol was approved by the Ethics Committee of the Faculty of Medicine in Universitas Sumatera Utara.

Participants

Total of 22 subjects with a consecutive sampling method. 11 participants in the endurance group and 11 participants in the strength group. Patients were given strength and endurance training with 28 egg-white supplementations each week for 4 weeks. Quality of life was measured by COPD assessment test (CAT) score.

The inclusion criteria were stable COPD patients aged 40-80 years who had not been involved in any exercise program for these one month. The diagnosis of COPD was established by history, and physical examination, then confirmed by spirometry examination with Global Initiative for Obstructive Lung Disease (GOLD) 2020 criteria (FEV1/FVC < 70). The exclusion criteria were patients in exacerbation state, who did not want to follow or had an irregular exercise program, and had malignancy.

Pulmonary Rehabitation Program

The Pulmonary Rehabilitation (PR) program included the following sessions:

1) Education about the methods for effective breathing (abdominal breathing and pursed-lip. breathing) and inhaler use.
2) Stretching and warming up.
3) Perform upper arm endurance or strength exercises.
4) Additionalintakeof7 egg-white supplementations per exercise for patient diet

Protocol

After all, the participants had understood the contents of the study and filled out the informed consent; they were scheduled for a training program. Before training, they had been given a short-acting beta-agonist (Salbutamol 2,5 mg) with a nebulizer, and they were confirmed in a clinically stable state when they came to the training program by a physician. First, they underwent warm-up and muscle stretching for avoiding muscle injury for 10-15 minutes. Then, upper limb training for 10 minutes was led by a physiotherapist and a video was prepared before. Upper limb training with breathing exercises consists of a few maneuvers such as:

1) Pursed lip breathing with exhaling while tilting your head towards your shoulder.
2) Bird-like pattern with inhaling while body straightening, exhaling while bending forward to the bottom.
3) No-way pattern with pursed-lip breathing, seeing a movement to left and right alternately.
4) Shoulder shrug with pursed-lip breathing.
5) Fan-like movement with pursed-lip breathing, hands are bent together, then turn right and left.
6) Chicken cuckoo-like movements with rotating the shoulder with hands bent at the shoulder.
7) Vampire-like movement, hands straight forward while inhaling, then rotating the body to the right, left, and forwards while exhaling.
8) Calling movement, the hand is lifted, then touched downwards, in the opposite direction.
9) Butterfly-like pattern, hands stretched straight forward then hands stretch.
10) It is cooling down.

This upper limb training was held four times a week for 4 weeks. Before and after every session of training, vital signs were measured and there were few physicians for leading and monitoring patients in the training program.

The followings were measured before and after the training

1) Quality of life is measured by the COPD Assessment Test (CAT) questionnaire. The result ≥ 10 from CAT indicates patients' quality of life was impaired.
2) The Dyspnea scale was measured by the Modified Medical Research Council (mMRC) which score of ≥ 2 indicates patients have more symptoms.

Nutritional Support

The nutritional support used in this study was the 7 egg-white supplementations per day four times a week after the exercise. The evaluation of whether the subjects consumed the egg-white Supplementation was by sending a photo of the time they ate the eggs. All those photos were sent to researchers.

Statistical Analysis

All the collected data was entered and analyzed by using Statistical Package for the Social Science (SPSS) for Windows version 16.0. Data was described in the distribution of frequencies and then analyzed using paired T-Test or Wilcoxon Test for bivariate analysis to know whether there is a significant change in lung function, dyspnea scale, and quality of life mean before and after the upper limb training program with egg-white supplementation.

3. Results

A total of twenty-two patients enrolled in this study consisted of women and men, aged 40-80 years old, with a diagnosis of stable COPD and adequate adherence of completed all sessions of upper limb training rehabilitation program with egg-white supplementation.

Table 1: General characteristics of participants in this study

Characteristics		Strength Training Group Participants		Endurance Training Group Participants		*p-value*
		n	*%*	*n*	*%*	
Age (Years Old)	40-49	1	9.1	0	0	*0,454*
	50-59	1	9.1	3	27.3	
	60-69	8	72.7	6	54.5	
	>69	1	9.1	2	18.2	
Sex	Male	10	90.9	7	63.6	*0,311*

	Female	1	9.1	4	36.4	
Smoking Status	Smoker	10	90.9	7	63.6	*0,311*
	Non Smoker	1	9.1	4	36.4	
Brinkman Index	Mild smoker	2	18.2	1	9.1	*0,082*
	Moderate smoker	1	9.1	4	36.4	
	Heavy smoker	7	63.6	2	18.2	
	Non-smoker	1	9.1	4	36.4	
Cigarette per years	<20	2	18.2	3	27.3	*0,164*
	20-30	1	9.1	2	18.2	
	>30	7	63.6	2	18.2	
	Non-smoker	1	9.1	4	36.4	

Table 1 showed the comparisons of clinical characteristics in endurance and strength training groups. From statistical analysis, it showed no significant difference in clinical characteristics including age, sex, smoking status, Brinkmann index, and cigarette per year in both groups, shown by a p-value > 0.05

Table 2: Characteristics of Research Subjects Based on the Severity of COPD

Severity of COPD		**Strength Training Group**			**Endurance Training Group**		
		n = 11			*n* = 11		
		n	*%*	*p-value*	*n*	*%*	*p-value*
BORG scale	Very light	1	9.1	*0.607*	0	0	*0,607*
	Light	1	9.1		0	0	
	Moderate	3	27.3		5	45.5	
	Somewhat strong	4	36.4		5	45.5	
	Strong	1	9.1		1	9.1	
	Very strong	1	9.1		0	0	
CAT score	CAT < 10	1	9.1	*1*	11	100	*1*
	CAT ≥ 10	10	90.9		11	100	
mMRC score	mMRC 0 – 1	4	36.4	*0.311*	1	9.1	*0.311*
	mMRC ≥ 2	7	63.6		10	90.9	

There was no significant difference in the severity of COPD between the strength and endurance training groups. Further characteristics as described in Table 2.

Table 3: Effect of Endurance Exercise and Muscle Strength with Addition of Egg White Nutrients on Quality of Life

Characteristics	**Strength Training Group**				*p-value*	**Endurance Training Group**				*p-value*
	Pre Test		Post Test			Pre Test		Post Test		
	Mean	SD	Mean	SD	0.001	Mean	SD	Mean	SD	0.002
CAT	23.81	5.81	15.72	6.34		21.72	6.95	15.63	6.88	

Table 3 showed an increased quality of life as assessed by the CAT. In the group that was given muscle endurance training with egg supplementations, there was a decrease in the CAT score from 21.72 to 15.63. This is significant based on a statistical test with a *p-value* 0.02. The same findings also are seen in patients who are given muscle strength training where there was a decrease in the CAT score from 23.81 to a score of 15.72. This is also significant according to the statistical test with a *p-value* of 0.000.

4. Discussion

This study showed an increase in the quality of life in both groups after being given endurance and muscle strength training with the addition of egg-white supplementations for 4 weeks which was assessed using CAT. It describes a decrease in COPD symptoms in patients' daily activities. A multicenter study conducted by James W Dodd in 2011 correlated CAT assessments before and after 8 weeks of pulmonary rehabilitation training and showed a significant difference in which 162 patients relieved symptoms after a pulmonary rehabilitation program[9]. Lacasse et al, a meta-analysis showed a reduction of shortness of breath and exercise capacity in COPD in stable COPD patients. The long-term effect was also affected and showed an increased quality of life [10]. Specifically for upper extremity training, Subin et al. showed that upper extremity training can improve quality of life, although they used a different method to measure the quality of life, using the Chronic Respiratory Questionnaire(CRQ)[2].

In Indonesia, a recent study with the same modifications of upper endurance extremity training without modifying egg-white supplementations described the significant improvement in the quality of life of COPD patients after being given exercise for 6 weeks. Characterized by a decrease in the CAT score (23.9 ± 5.5 to 18.3 ± 5.2; p-value: 0.000)[11].In addition, regular exercise can increase the social, emotional, and mental effects. Patients can be more confident to control their complaints and symptoms in daily life so exercise indirectly contributes greatly to improving the quality of life of patients with stable COPD after an upper extremity training program[11,12].

Nutrition itself is an important part of pulmonary rehabilitation because in COPD patients there is a decrease in muscle mass due to systemic inflammation that occurs in

COPD. TNF-α is one of the main cytokines secreted due to chronic inflammation of the airways that manifest systemically and causes an increase in the basic metabolic rate and protein catabolism. As a place for the most protein reserves, limb muscles are the largest targets of COPD catabolism so COPD patients will tend to experience a decrease in muscle mass[1,13–15]. So that the provision of nutrition will have a positive effect on increasing muscle mass in COPD patients [6].

Several studies have shown changes in the concentration of amino acids in the blood test of COPD patients. Amino acid supplementation in this case soy milk can increase overall protein synthesis in COPD patients and affect protein metabolism in extremities in COPD patients [16]. Oral amino acid supplementation in COPD patients not only improves muscle protein metabolism but improves oxygen distribution in the body, cognitive function, and overall quality of life. In addition, another study showed that COPD patients with severe obstruction who were unable to participate in pulmonary rehabilitation programs due to shortness of breath experienced improved performance status, quality of life, nutrition, cognitive function and muscle strength after administration of amino acid supplementation[17].

Amino acids are the result of protein metabolism, so protein supplementation will have almost the same effect as amino acid supplementation. Egg-white supplementations as the simplest and easiest source of protein are considered to improve nutritional status and improve muscle mass in COPD patients. This improvement in muscle mass will be in line with an increase in the quality of life of COPD patients as a further impact[16].

There are some limitations of this study, including the number of participants and the methodology used. A small group of participants can make it difficult to rule out the personal factor that could interfere with the result of this study. In the method, this study did not have a control group so we could not make a comparison between the intervention study and the control group.

From this study, we can conclude that upper limb training with egg-white supplementation gives a positive impact on stable COPD. There was a significant improvementin quality of life in stable COPD patients after 4 weeks of training. So, upper limb training must be a part of a pulmonary rehabilitation program in the comprehensive treatment of COPD.

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