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EVALUATION OF UPPER LIMB EXERCISE WITH RESPIRATORY MUSCLE STRETCH GYMNASTICS FOR LUNG FUNCTION AND QUALITY OF LIFE IN COPD PATIENTS

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ABSTRACT

Progressive decline in pulmonary function can be unveiled by shortness of breath and lower physical ability, and decreased life quality among COPD. This study aimed to investigate the effects of Upper Limb Exercise with Respiratory Muscle Stretch Gymnastics for lung function and quality of life in COPD patients. A quasi-experiment design (pre-post test with control group design). 50 respondents participated, divided into two groups at Airlangga Hospital and Bangil Regency Hospital, Indonesia, with consecutive sampling. Data were collected by a spirometry test for lung function using the COPD Assessment Test (CAT), subsequently was analyzed by employing aired T-test and MANOVA test. Treatments were given three times a week for a month. The outcome showed that the treatment group increased lung function with FEV1 value and quality of life before and after the treatment with a value of 0.000 ($p<0.05$), but the control group was otherwise. There were lung function and quality of life values with MANOVA of 0.011 ($p<0.05$). Upper Limb Exercise with Respiratory Muscle Stretch Gymnastics improve lung function and quality of life among COPD patients to complement pharmacological therapy.

Keywords:
Chronic respiratory, Lung function, Quality of life, Respiratory muscle stretch gymnastics, Upper limb exercise

BACKGROUND

COPD (Chronic Obstruction Pulmonary Disease) is a respiratory disease with persistent, preventable, and treatable limited airflow breathing (GOLD, 2020). Global Burden of Disease Study reported that the prevalence of COPD reached 251 million cases in 2016. It is estimated that in 2015, there were 3.17 million deaths worldwide due to COPD disease, which equals to 5% of all deaths globally. Amounted to more than 90% of deaths due to COPD occurred in low and middle-income countries. The figure is likely to rise in the upcoming year due to higher smoking prevalence and the aging population in various countries (WHO, 2017). The prevalence of COPD in Asian countries is categorized as moderate to severe, at the rate of 6.3%, which constitutes 3.5% in Hong Kong and Singapore, 5.6% in Indonesia, and 6.7% in Vietnam (Viet et al., 2015).

Flow resistance in COPD causes a progressive decline in pulmonary function and manifests shortness of breath and decreased physical ability, and de-

creased life quality (Incorvaia et al., 2014). Decreased COPD pulmonary function is assessed through airflow during expiration. The decrease of FEV1 is profoundly related to the symptoms that appear, and the incidence of exacerbations (Tantucci & Modina, 2012). COPD patients hold a low quality of life, cognitive dysfunction, and more fatigue symptoms than those without COPD. The condition impairs COPD patients' daily lives in the sense of social environment and satisfaction in receiving help (Franssen et al., 2018). Their physical activity is less energetic, including in the early stages of the disease. Patients also frequently feel helpless to complete their every motion and consider themselves as a burden for others (Miravitlles & Ribera, 2017).

Esquinas et al. (2019) posited that acceptance of the disease due to limitations and unpleasant feelings due to the disease is considered important as an indicator of the quality of life (Esquinas et al., 2019). Improving patients' quality of life with COPD requires a rehabilitation program that can subdue symptoms, although barely applied in a tertiary hospital or primary facility (PDPI, 2016). Lung rehabilitation is a cost-effective therapy, as it revives chronic lung disease; additionally, it may boost recovery possibility (Singh, Halpin, Salvi, Kirenga, & Mortimer, 2019). Pulmonary rehabilitation is a core regiment nonpharmacologic therapy for chronic respiratory disease (Spruit et al., 2013). Short term program had shown result significance with COPD patients (Baidya, Coppieters, Solomen, & Aaron, 2018).

Upper Limb Exercise, as one of the new rehabilitation program, have some benefits (Magalhães, Neto, & Saquetto, 2018). Resistance training investigated after a meta-analysis provided satisfactory results in decreasing dyspnea, increasing predicted FEV1 values, improving quality of life, skeletal muscle strength, enhancing pulmonary function, and promoting functional exercise capacity (Liao et al., 2015). Respiratory Muscle Stretch Gymnastics reduces dyspnea, improves the quality of life, and reduces anxiety due to activation of the limbic system (Toyodera et al., 2013). Respiratory Muscle Stretch Gymnastics has also been proposed as a possible additional form of rehabilitation recommended for patients among COPD (Minoguchi et al., 2002). Improvements in dyspnea, exercise capacity, and health status are considered to improve daily activities and social systems, resulting in improved psychologic function with rehabilitation pulmonary (Gordon et al., 2019). However, the results shown by the combination rehabilitation programs have not yet been thoroughly explored. The aim of this study was to investigated the effects of Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics on lung function and quality of life in COPD patients.

METHODS

A quasi-experiment design (pre-post test with control group design) without randomization was performed. This study's sample size was 50 respondents divided into the treatment and control groups (n=25, each group) with consecutive sampling. This research was conducted from December 2019 to February 2020 in Airlangga Hospital and Bangil Regency Hospital, Indonesia. Airlangga Hospital is a treatment group, while Bangil Regency Hospital is a control group. The inclusion criteria in this study were: patient diagnosed COPD with history and physical examination and confirmed by forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) <70%, clinically stable (no worsen symptoms during exercise), has not taken systemic steroids for a long time, does not own a cognitive impairment, and literate. The exclusion criteria in this study were: patient has a malignancy, diseases that affect the muscles and joints or hospitalized three times due to COPD disease within 6 months. The dependent variable is Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics. The independent variable is lung function and quality of life in COPD patients.

Pulmonary function tests were measured by spirometry to obtain the percentage predicted of FEV1/FVC to diagnose COPD and obtain FEV1 value. Lung function evaluates FEV1 value. This study used the COPD Assessment Test (CAT) to evaluate the quality of life. This questionnaire into the following of 8 statements. The scores ranged from 0 to 40. We conducted a pre-test assessing dyspnea and quality of life using a predetermined measuring instrument for each of the groups. The treatment group received Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics, while the control group received standard therapy in Bangil Hospital. The treatment group performed at the hospital for four weeks, with a total duration of 45-60 minutes, three times a week. It comprised of 10 minutes of warming-up session, 15 minutes of core session, and 10 minutes of cooling down. Before and after the exercise, we examined vital signs consisting of respiration rate, oxygen saturation, blood pressure, and heart rate. Performance on core consists of Upper Limb Exercise with nine movements, eight repetitions each movement, and the total load was 1

kg for the two first weeks and 2 kg for the next two weeks. After 10 minutes of resting, performance continued. Respiratory Muscle Stretch Gymnastics consists of three sessions, with five patterns in each session, and four repetitions in each pattern. Pulmonologists and nurses supervised all laboratory training. The Control group received standard therapy treatment in the hospital, only pharmacology and education from health professionals without treatment. The fifth-week respondents were asked to return to fill out the dyspnea questionnaire and quality of life and FEV1 measurement as a post-test scheduled in both the treatment and control groups.

This research protocol was approved and passed the ethical test by the Health Research Ethics Commission of the Airlangga University Hospital with a certificate of ethics number 189/KEH/2019 and the Health Research Ethics Commission of the Bangil District Hospital number 445.1/3255.4.424.202/2019 to protect human rights and patient welfare from therapy.

Data entry was performed using the SPSS software version 21. The descriptive analysis was expressed as a distribution for respondent characteristics, as in demographic data instrument consisting of age, sex, education, occupation, GOLD criteria, history of smoking, and Body Mass Index. We employed using the normality test of Shapiro Wilk to run a statistical inferential test, following by a parametric paired T-test and MANOVA test with a significance level of 0,05.

RESULTS

That 50 respondents participated in this research; 25 people (44%) were >65 years old, 45 people (90%) were men, 21 people (42%) were in elementary school, 29 people (58%) were unemployed, 16 people (32%) were GOLD 3, 38 people (76%) had smoking history, 35 people (70%) had 18,5-24,9 kg/m2 body mass index (Table 1).

Quality of life in the treatment group, there were 13 respondents (52%) had a very good quality of life, 9 respondents (36%) had good quality of life, 3 respondents (12%) had a moderate quality of life, no one has a poor quality of life. After four weeks of treatment exercise, there were 18 respondents (72%) with very good quality of life, 7 respondents (28%) had good quality of life, no one had moderete and poor quality of life (Table 2).

Meanwhile, dyspnea in the control group, there were 7 respondents who (28%) had a very good quality of life, 16 respondents (64%) had a good quality of life, 2 respondents (8%) had moderate quality of life, no one has a poor quality of life. After four weeks, there were 9 respondents (36%) who had very good quality of life, 15 respondents (60%) had good quality of life, 1 respondents (4%) had moderete quality of life, no one had poor quality of life (Table 2).

The treatment group in FEV1 obtained the pre-test mean of 1.0412 ± 0.41850. Whereas after four weeks, the mean value of post-test lung function was 1.1664 ± 0.48316 in the intervention group, and the delta value was 0.1252. Paired T-test results in the treatment group showed significant differences between the quality of life before and after Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics, with a value of 0,000 ($p < 0.05$). The control group obtained the pre-test mean of 0.9252 ± 0.38371. After four weeks, the mean value of the post-test quality of life was 0.9380 ± 0.35522 in the treatment group, with a delta value of 0.0128. Paired T-test resulted in the control group revealed that there were no significant differences between the quality of life before and after Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics with a value of 0,340 ($p > 0.05$) (Table 3).

The treatment group in quality of life obtained the mean of pre-test 12,04 ± 6,804. After four weeks, the mean value of the post-test quality of life was 7,96 ± 3,846 in the treatment group, with a delta value of -4,08. Paired T-test resulted in the treatment group designated significant differences between the quality of life before and after Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics with a value of 0,000 ($p < 0.05$). The control group reached a pre-test mean of 12,96 ± 4,835. After four weeks, the mean value of the post-test quality of life was 12,12 ± 5,403 in the treatment group, with the delta value of -0,84. Paired T-test results in the control group explicated that there were no significant differences between the quality of life before and after Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics with a value of 0,434 ($p > 0.05$) (Table 3).

The variance-covariance similarity individually shows the value of the Box test, which, in this case, revealed a significant number. The box test value was 0.119, which indicated that variance-covariance to be the same for each group. Assuming the similarity of the variance-covariance matrix has been fulfilled, the MANOVA analyst process could proceed. The hypothesis test showed significant figures for the intervention group. The control group was examined by the Pillai Trace, Wilks Lamda, Hotelling T, and Roys Lagest Root procedures, indicating the value

Table 1. Characteristics of Respondents

Characteristics	Group				Total	%
	Treatment		Control			
	f	%	f	%		
Age						
46-55 years	1	4	2	8	3	6
56-65 years	9	36	13	52	22	44
>65 years	16	60	10	40	25	50
Gender						
Male	24	96	21	84	45	90
Female	1	4	4	16	5	10
Education						
Elementary school	4	16	17	68	21	42
Junior high school	6	24	2	8	8	16
Senior high school	10	40	4	16	14	28
University	5	20	2	2	7	14
Occupation						
No worked	15	60	14	56	29	58
Retired	5	20	1	4	6	12
Entrepreneur	5	20	5	20	10	20
Farmer	0	0	4	16	4	8
etc	0	0	1	4	1	2
GOLD Criteria						
GOLD 1	4	16	4	16	8	16
GOLD 2	10	40	4	16	14	28
GOLD 3	6	24	10	40	16	32
GOLD 4	5	20	7	28	12	24
Smoking History						
Yes	20	80	18	72	38	76
No	5	20	7	28	12	24
Body Mass Index						
≤ 18,4 kg/m^2	5	2	4	16	9	18
18,5 – 24,9 kg/m^2	17	68	18	72	35	70
25-29,9 kg/m^2	3	12	3	12	6	12
>30 kg/m^2	0	0	0	0	0	0

Tabel 2. Upper Limb Exercise a Combination of Respiratory Muscle Stretch Gymnastics on Dyspnea in the Treatment and Control Groups

Variable	Grades	Treatment group				Control group			
		Pre		Post		Pre		Post	
		f(x)	%	f(x)	%	f(x)	%	f(x)	%
Quality of life	Very good	13	52	18	72	7	28	9	36
	Good	9	36	7	28	16	64	15	60
	Moderate	3	12	0	0	2	8	1	4
	Poor	0	0	0	0	0	0	0	0

of <0.05. As the P-value explicated a significant value, the hypothesis test is accepted: simultaneously, there is an effect of Upper Limb Resistance Exercise for Respiratory Muscle Stretch Gymnastics on lung function and quality of life in COPD patients (Table 4).

DISCUSSION

Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics affects Forced Expiratory Volume in One Second (FEV1) and the quality of life of COPD patients in the treatment group, be-

Table 3. Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics for Lung Function and Quality of Life in COPD Patients

Variable	Group	Pre Test (Mean ±SD)	Min-Max	Post Test (Mean ±SD)	Min-Max	P*
FEV_1 (Liter)	Treatment	1.0412 ± 0.41850	0.44-2.08	1.1664 ± 0.48316	0.59-2.48	0.000
	Control	0.9252 ± 0.38371	0.41-1.85	0.9380 ± 0.35522	0.40-1.75	0,340
Quality of life	Treatment	12.04 ± 6.804	2-27	7.96 ± 3.846	2-15	0.000
	Control	12.96 ± 4.835	3-21	12.12 ± 5.403	2-23	0.434

**Paired T-test*
SD – standard deviation

Table 4. Result Multivariate Analysis of Lung Function and Quality of Life

Variable	Groups	SD	P-*value**			
			Box test	Lavene	Between subject	Manova
FEV_1	Treatment	0.48316	0,119	0.173	0.063	0.011
	Control	0.35522				
Quality of Life	Treatment	3.846		0,128	0,003	
	Control	5.403				

fore and after treatment. In the control group, patients received hospital-standard interventions in pharmacological therapy and health education, which also showed a slight increase of 12 ml of the FEV1 value and quality of life. This study proved that Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics influences the value of FEV1 and quality of life, however may be conditional in the control group.

This research follows Tarigan et al. (2019), which proved that upper limb exercises combined with breathing maneuvers, can improve pulmonary function, especially in FEV1 and FVC values. Preceding research also confirmed that all breathing exercises could increase FEV1, FVC, and inspiration capacity compared to the control group (Karn, Hassan, Fadl, & Mahmoud, 2018). Separate studies explicated the predicted FEV1 value is higher upper limb than lower limb exercise, although it cannot be explained in depth (Novianti, Suradi, & Doewes, 2015). Other reviews proved the Upper Limb Exercise impacts functional capacity training, the performance of daily activities, and quality of life. Improved quality of life occurs in all domains, namely symptoms, activities, and psychosocial (Magalhães et al., 2018). The corresponding result is also supported by a study conducted by Yekefallah et al. (2018) who asserted that there was an influence on the quality of life by doing upper limb training and breathing exercises.

Combining physical exercises such as upper limb with breathing techniques in this study using breathing techniques with stretching muscles is needed to rehabilitate chronic respiratory diseases such as COPD. COPD is a chronic inflammatory respiratory disease that requires comprehensive rehabilitation. Soewito (2016) explained that COPD patients were also proven to lose fat-free mass, which harmed respiratory function, peripheral muscles, exercise capacity, and patient health status. The FEV1 value that increased in the treatment group after being given for four weeks showed that upper limb exercise overcame the ventilation barrier in COPD patients. This result may be interpreted from the correlation between upper limb muscle strength, hand skills, and lung function changes, especially FEV1 values (Safran & Yildiz, 2016). The mean increase in FEV1 values for respondents who were treated before and after the implementation of Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics was 0.12 liters or 120 ml. It is recognized that there is a decrease in FEV1 of 47-79 ml/year in patients with respiratory obstruction (Incorvaia et al., 2014). This method can prevent a further decline in FEV1 values each year among COPD patients.

Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics can also contribute to the quality of life because exercise can be related to exercise activity in central monoamine function, which increases the hypothalamus, pituitary regulation of the adrenal axis, raises spending on endogenous opioids, and reduces systemic inflammation. This situation is directly related to decreased patient symptoms (Tselebis et al., 2016). In rehabilitation programs involving breathing stretches resulting in a low

CAT score, the aforementioned happens to condition breathing can reduce wall stiffness and increase chest flexibility in respiratory muscles, resulting in decreased hyperinflation. The effects of this state of respiration will reduce symptoms, feel relaxed and reduce anxiety to promote daily activities and quality of life (He, Yu, Wang, Lv, & Qiu, 2015). A short 3-weeks program with Respiratory Muscle Stretch Gymnastics exercises is also known to boost well being and increase daily activities to affect the quality of life of COPD patients (Bhasin & Subramanian, 2012). Upper limb physical exercise reduces the state of hyperinflation because it encourages increased respiratory effort, reduces lactic acid, and regulates breathing patterns for the better (Lee et al., 2019). These results support that Upper Limb Resistance Exercise with Respiratory Muscle Stretch Gymnastics can affect COPD patients' quality of life.

It has been known that regular and intensive exercise in COPD patients will affect cardiopulmonary function, hormonal balance, and biochemical tissue. Regular exercise will induce oxidative capacity and decrease ventilation in submaximal workloads and decrease oxygen consumption in submaximal workloads. Exercise can increase myoglobin in the amount of type 1 skeletal muscle fibers that contribute to helping the process of oxygen diffusion from cell membranes to the mitochondria (Tarigan et al., 2019). Upper Limb Exercise has shown that daily arm activity requires shoulder elevation to regulate regular breathing and dynamic hyperinflation, so this is the most critical factor in exercise capacity in COPD patients (Kaymaz et al., 2018). Respiratory Muscle Stretch Gymnastics affects breathing and chest muscles, one of which is the intercostal muscles. This exercise will experience intercostal muscle repair, which helps the ribs' movement develop the posterior-anterior diameter of the thoracic cavity associated with an increase in FEV1 and reduction in dyspnea and chest expansion and make changes in ventilation parameters due to the release of muscle spindles during the passive stretching phase. A hypothesis put forward by intercostal muscles helps in aspects of the breathing mechanism and can experience atrophy if a person's physical activity worsens, which ends with the onset of shortness of breath. Intercostal stretching can stretch and activate receptors in the chest wall and be neurologically related to the medulla and efferent nerve (Ashwini, Bhagyashri, & Medha, 2017).

There were no mean differences in the control group before and after four weeks that were given standard therapy from the hospital in the form of pharmacological treatment because of short-term rehabilitation for four weeks, while the treatment would be useful for around 3-6 months. The condition is explained by the absence of confirmation of improvement in all domains of quality of life by the use of drugs that receive theophylline or salmeterol or both that were carried out by observational testing although they could not evaluate the real effects of the treatment (Liang et al., 2014). Some patients who smoke may be the explanation of influences on the FEV1 value. FEV1 values are also associated with endothelial failure in systemic blood vessels evaluated from dilated arteries that have been injured. Cells released by the membrane when injured or apoptosis are endothelial microparticles (EMP), which can be found in disorders of blood vessels, coronary heart disease, stroke, kidney failure, and smokers. The study by Takahashi et al. (2014) mentioned that high EMP triggers early lung damage that is found in a smoker who destroys pulmonary capillary endothelium and inflammation even in stable COPD conditions(Takahashi et al., 2014). A high smoking index influences the quality of life, especially in the symptom domain in patients who describe the patient's psychological state as well (Zamzam, Azab, Wahsh, Ragab, & Allam, 2012).

Besides, the control group and the treatment group were predominantly male and had GOLD criteria 3. The condition is similar to what was performed by (Leem et al., 2019), which explained a decrease in pulmonary function over time in men with COPD, and the rate of decline in FEV1 can be slow if stopping smoking in the pre-bronchodilator test. The control group also had more female sex than the treatment group. The dominance is considered as the cause of mean values difference between the treatment and control groups. Women with cough or worsening exacerbation symptoms will experience a faster decline in FEV1 value (Perez-Padilla et al., 2017). Through clinical trials on female mice, it showed that low estrogen influences oxidative stress, remodeling of small airways, and airway obstruction (Barnes, 2016). Women become susceptible to having COPD because of the influence of estrogen levels. At a young age, estrogen can induce and differentiate in lung maturation. However, when women enter the menopause phase, the estrogen levels decline and cause a decreased lung function, which impacts the decreased FEV1 value, especially those with smoking history (Sansores & Ramírez-Venegas, 2016). Quality of life is also affected by shortness of breath, worsening of activity, decreased psychological state, social function, high airway limitations, loss of hope,

anxiety, dyspnea, low education level, low body mass index, depressive symptoms have contributed to the decline in the quality of life of people with COPD (Sharma & Joshi, 2015). This study has limitations, including evaluating the post-test scores in the treatment and control groups that are not executed simultaneously and the result of research shouldn't not be generalized because this research was peformed by without randomization.

CONCLUSION

Upper Limb Exercise combined with Respiratory Muscle Stretch Gymnastics used in addition to conventional rehabilitation methods, was found to be effective increase lung function FEV1 value and improve the quality of life in COPD patients. This exercise can also become pharmacological support therapy. Additionally, this exercise is safe and easy to do.

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