ORIGINAL ARTICLE

Effects of Ergo-Cycle Exercise on Lung Function and Physical Fitness of Chronic Obstructive Pulmonary Disease

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ABSTRACT

Objectives : To observe the effect of ergo-cycle exercise on lung functional capacity and physical fitness level of COPD patients, to observe relationship between lung functional capacity and physical fitness level of COPD patients before and after regular ergo-cycle exercise.

Methods : Quasi-experimental research of twenty eight subjects with mild and moderate COPD who came to Medical Rehabilitation Instalation. They conducted ergo-cycle exercise for 30 minutes 3 times a week, by one day interval, for 4 weeks. This research was a pre and post test design.

Results : There was a significant increase on some lung function parameters such as % FEV1, % FVC, but it didn't happen with FEV1/FVC ratio ($p < 0.001$; $p < 0.001$; $p = 0.3$). The result of measurement 6-MWD indicated a significant increase score ($p < 0.001$). There was a significant change on severity of COPD before and after ergo-cycle exercise for 4 weeks. Mild COPD as 8 subjects at the initial study became 15 subjects after the exercise, and moderate COPD as 20 subjects became 13 subjects after the exercise ($p = 0.002$). Relationship of lung functional capacity with 6-MWD indicated significant correlation on % FEV1 and % FVC, but not on % FEV1/ %FVC ratio.

Conclusions : Thirty minutes ergo-cycle exercise for 3 times a week within 4 weeks is respectively able to increase lung functional capacity and physical fitness level of mild and moderate COPD patients. There is positive correlation between lung functional capacity with physical fitness level on COPD patients.

Keywords: *COPD; Lung Functional Capacity; Physical Fitness Level; Ergo-static Bicycle Exercise; 6-MWT.*

INTRODUCTION

Chronic Obstructive Pulmonary Disease (COPD) is a preventable and treatable disease with some significant extra-pulmonary effects that may contribute to the severity in individual patients. Its pulmonary component is characterized by airflow limitation that is not fully reversible. The airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lung to noxious particles or gases.[1]

COPD is commonly and progressively found now a days both in developed and developing countries. It closely relates to increase and complexity of its risk factors . Increasingly advanced technology, industries, air pollution, cause the increasing of COPD patients.[3,4] Moreover in Indonesia, more people smoking, tobacco industry and motor vehicle is bigger and stronger, while low socioeconomic condition, high levels of urbanization, especially increase of tuberculosis infection, involved in increasing the disease.[2,3,4]

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In the United States, incidence and prevalence of COPD mortality in 1995 estimated 16 million patients as the fourth largest causes of death after cardiovascular, cancer, and cerebral vascular disease. COPD also as the second largest after cardiovascular for people under of 65 years disabilities.[2,3,4] COPD is the only one of ten causes of death that is still increase.[5] In Europe on 1990, COPD mortality exist at ranked 12th and estimated to be at 5th – ranked on 2020. WHO, in 1990 projected COPD as the sixth leading cause of death and will be the third in the world on 2020.[1-5] *Survei Kesehatan Rumah Tangga*, Ministry of Health of Indonesia in 1995 noted that prevalence rate was 13% and mortality rate would be the fifth highest cause of death for chronic bronchitis, pulmonary emphysema, and bronchial asthma.[6]

In term of functional disorder, COPD is a group of disease characterized by limiting airflow during expiration and irreversibly. Frequently symptoms is breathlessness as the main cause of inactivity that result patients to the state of physical de-conditioning, decline of functional ability in activity daily living and decrease quality of life. Progressively, COPD advance in severity while the phases of acute exacerbation lead to worsening of lung capacity, therefore it requires proper management.[3-5,7,8]

Management of COPD mainly to relieve symptoms, prevent de-conditioning syndrome, increase functional capacity, prevent and reduce frequency of exacerbations mortality, improve ability of activity daily life, achieve optimally self-ability, improve quality of life. This requires comprehensive treatment. Benefits of exercise have been reported improve and enhance the ability of cardiopulmonary system, thereby increase physical abilities. Recommended exercise is aerobic, which is performed continuously. Aerobic exercise involving large muscle groups in dynamic, repetitive, rhythmic, and sub-maximally without fatigue. It can be walking, running, cycling, treadmill, skiing, etc. [9,10-14]

Pitta F, et al (2003)[15] examined the effects of ergo-cycle exercise for 30 minutes, 3 a weeks during respectively 8 weeks on 25 moderate and severe COPD shows an increase in % FEV1 and % FVC, and significant improvement of functional ability (6-MWD). Bernard S, et al (1999) [16] observed about *ergo-cycle exercise* 30 minute 3 a week for 12 weeks, is safe and provide significant change of quadriceps femoral muscle strength and quality of life in COPD patients. Rosdiana I, [17] reported a cross sectional study on 30 COPD patients, states a positive correlation between degree of lung obstruction measured by Spiro-metric; VO2 max measured by 6-MWD. This study hypothesized that there will be improvements in lung functional capacity and physical fitness level of COPD patients after regular ergo-cycle exercise, and positive correlation on both parameters before and after undergoing the exercise.

METHODS

Participants were COPD patients admitted from Pulmonology subdivision of Physical and Medical Rehabilitation Installation. They were selected by consecutive sampling and enrolled after an assessment and a physical examination screening for exclusion criteria as follows: disability from cardiovascular disorders or NYHA III - IV of heart failure, disability from neuromuscular disorders of lower extremities such as stroke and paraparese, from musculoskeletal disorder of lower extremities such as knee osteoarthritic, patients with tuberculosis, BTA (+), acute exacerbation, resting systolic blood pressure >140 mmHg, resting diastolic blood pressure >90 mmHg, diabetic melitus, severe visual deficiency, cognitive impairment.20-23 Inclusion criteria included outpatient COPD, aged 40 – 65 years old, mild and moderate severity, stable state at least during this one month, consume standard medication, no habits with bike, BMI less than 25, walk independently, able to perform 6 MWD, cooperative with the procedure of research, and signed informed-consent. Drop out criteria did not complete the exercise respectively twice or amount of exercise session less than 8, withdrawal from the study, attacked of acute exacerbation.

6-MWT is a practical simple test that requires a 100-ft (±30 meter) hallway but no exercise equipment or advanced training for technicians. The length of the corridor should be marked every 30 m. The turn around points should be marked with a cone. A starting line, which marks the beginning and end of each

60-m lap, should be marked on the floor using brightly colored tape. This test measures the distance that a patient can quickly walk on a flat, hard surface in a period of 6 minutes (6-MWD).

The Spiro-metric test is conducted by Enraf Nonius Spiro-metric. Before the test, subjects data that consist of name, age, sex, height body, weight body, and ethnic was entered. Subjects performed breathing as maximal inspiration and forced expiratory volume in 1 second was recorded by connected mouth-piece to the tool. Test was repeated until 3 times for best quality of the data as describing lung functional capacity of subject. Percentage of FEV1, FVC, % FEV1/FVC-ratio predicted and measured were displayed and noted as a main data.[18,19]

Eligible subjects were explained about the study and performed spirometry test and 6-MWD one or two days before exercise. Ergocycle exercise were done by all the subjects 30 minutes 3 times a week, by one day interval during 4 weeks respectively. Exercise consist of warming-up for 3 -5 minutes continued by 20 minutes riding ergostatic cycle. Intensity was determined as 50 – 60 rpm riding velocity. Cooling-down must be done after it by slowing down the riding velocity or walked around for about 5 minutes. Heart rate were noted before the exercise, at 10th minute, 20th minute, at the end of exercise, and at 5th minute after exercise. Exercise had to been interrupted if the HR max > 70 % or if there was any symptoms of breathlessness and fatigue. Post evaluation was performed by spirometry test and 6-MWT.

Statistical analysis was performed by using SPSS for Windows v.15,0 (SPSS Inc, USA). Lung function parameters and 6-MWT data were expressed as the mean and standard deviation (SD) or as median if data distribution is not normal and differences on both were tested by unpaired t-test. Changes on lung functional capacity with 6-MWT measurement before and after the exercise was analised by Mann-Whitney test. Correlation among different with both parameters were analised by Spearman's correlation. Significant if p<0,005, 95% coefficient correlation.

RESULTS

Table 1 shows the distribution of subjects recruited in this study, describes age, gender, educational level, occupation, length of work and residence. The assessment of lung functional capacity and 6-MWD before and after ergo-cycle exercise for 4 weeks shown in table 2.

Table 1. Characteristics of study subjects

Characteristics	N (%)	Mean ± SD
Age (y)		53.2 ± 6.26
Sex		
- Male	18 (64.3)	
- Female	10 (35.7)	
Age by sex (y)		
- Male		54.7 ± 5.03
- Female		50.5 ± 7.55
Level of education		
- Elementary	15 (53.6)	
- Junior High School	7 (25.0)	
- Senior High School	6 (21.4)	
Occupation		
- Housewife	1 (3.6)	
- Civil Service	12 (42.9)	
- Private	1 (3.6)	
- Trading	2 (7.1)	
- Labor	10 (35.7)	
- Domestic helper	2 (7.1)	
Length of work (y)		27.5 ± 5.53
Residence		
- In the area	28 (100)	
- Out of area	0 (00	

Mean ± SD : Mean ± Standard Deviation

Table 2. The assessment of lung functional capacity and 6-MWD before and after ergo-cycle exercise for 4 weeks

The assessment of lung functional capacity and 6-MWT	Measurement			P
	Before Mean ± SD (n=28)	After		
		Mean ± SD (n=28)	Δ	
FEV1 measured (L)	1.4 ± 0.49	1.6 ± 0.58		-
FEV1 predicted (L)	2.3 ± 0.53	2.3 ±0.53		-
%FEV1 (L)	61.0 ± 12.93	71.0 ±17.00	10.0	< 0.001*
FVC measured (L)	1.8 ± 0.57	2.0 ±0.67		-
FVC predicted (L)	2.8 ± 0.67	2.8 ±0.67		-
%FVC	62.3 ± 11.81	70.6 ±13.46	8.3	< 0.001*
FEV1/FVC ratio (%)	79.5 ± 10.84	81.4 ±11.65	1.9	0.3*
6 MWD (meter)	383.3 ± 37.83	436.5 ±48.99	53.2	< 0.001§

* Unpaired t-test ; § Mann-Whitney test
Mean ± SD : Mean ± Standard Deviation ; 6-MWD : six – minutes walk test distance ; FEV1 : Forced Expiration Volume in one second ; FVC : Forced Vital Capacity ; L : liter

Changing in lung function parameters and 6-MWD shown in figure 1, 2, and 3.

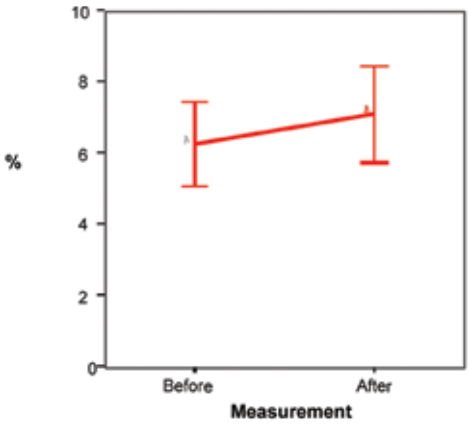

Figure 1. Increasing of % FVC before and after ergo-cycle exercise for 4 weeks (n=28)

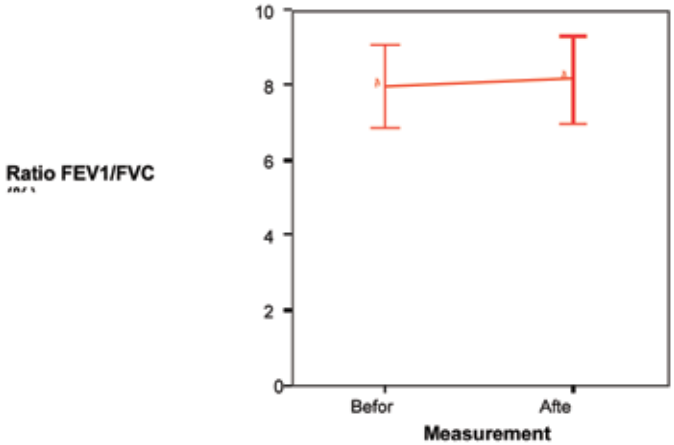

Figure 2. Increasing of FEV1/FVC before and after ergo-cycle exercise for 4 weeks (n=28)

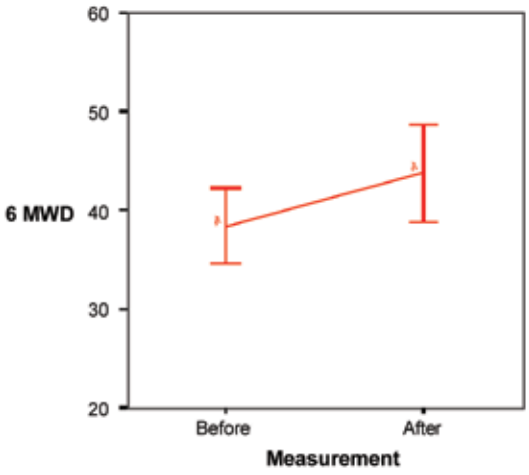

Figure 3. Increasing of 6-MWT before and after ergo-cycle exercise for 4 weeks (n=28)

There were changes on severity of COPD before and after ergo-cycle exercise in 4 weeks. Mild COPD as 8 subjects at the initial study became 15 subjects after the exercise, and moderate COPD as 20 subjects became 13 subjects after the exercise. This study showed that these changes were significant (p=0,002). The relationship between lung functional capacity with 6-MWD is shown in table 3.

Table 3. The relationship between lung functional capacity with 6-MWD (n=28)

Relationship between lung functional capacity with 6-MWD	Correlation Coefficient	P*
%FEV1 with 6-MWD	0.57	< 0.001
%FVC with 6-MWD	0.62	< 0.001
%FE1/FVC ratio with 6-MWD	0.22	0.96

*Spearman Correlation test

DISCUSSION

Generally COPD affects elderly. This study found most of subjects classified as elderly patients by mean of age 53,2 ± 6,26 years. Compared with previous studies in Indonesia it seems lower due to degree of severity or stages included only mild and moderate COPD.[9,14-17,27-31]

Characteristics of COPD patients in this study consist of 57,1 % pink puffer and 42,9 % *blue bloater* with respectively 28,6 % and 71,4 % mild and moderate COPD according to the theory of progressive COPD particularly by absence of any treatment. There were changes on severity of COPD before and after ergo-cycle exercise in 4 weeks.[14,15,28,36] A number of 8 subjects as mild COPD became 15 subjects after the exercise, and 20 subjects as moderate COPD became 13 subjects after the exercise. Statistical analysis showed these changes were significant (p=0,002). This study proved that ergo-cycle exercise meet goals of COPD management to prevent progressiveness of the disease.[7,17,24]

There were significance on physiologic responses and safe to ergo-cycle exercise proved by blood pressure, pulses, respiratory rate, and Borg scale in COPD patients. The result also showed %FEV1 and % FVC before and after ergo-cycle exercise were lower level of normal value. Physical activity limitation caused by decrease of fitness level showed by lower of 6-MWD. However, there is airflow reducing but total lung capacity and residual volume increasing caused by hyperinflation on COPD patients due to decreasing of vital capacity and inspiration capacity. [25,26,29-31]

This study shows the effects of ergo-cycle exercise in 4 weeks as increasing on

lung functional capacity and physical fitness level of COPD patients according to previous studies.[14-16] In contrast to this study, they confirmed the increasing were not significant by possible reason differences on severity of COPD subjects and on exercise intensity. [15,16,35] Even-though, effects of ergo-cycle exercise on asthma and spinal cord injuries patients were reported as a significant improvement of VO2max and physical fitness.[32-34]

There were significant improvements in 6-MWD obtained accordance with previous studies such as Rosdiana I at Semarang, Kurniadi G at Jakarta, and Tianusa N at Manado, and positive correlations between lung functional capacity with 6-MWD (FEV1 with 6-MWD r = 0,503, FVC with 6-MWD r = 0,493; 6-MWD with domain of quality of life, by mean r = 0,537).[17,29,30]

Aerobic exercise like ergo-cycle was one of choices that can be performed by COPD patients. Intensity on 70% HR-max with 3 times a week in frequency and continuously 30 minutes duration showed significant improvement of lung functional capacity. Literature states that it is safe to perform exercise until achievement of 60-80% HR-max. Interval exercises performed are able to achieve the effects by reducing lactic acid level, increase endurance and quality of life as good as continuously exercise.[25,26,28,31,36,37]

The limitation of the study is that we did not measure blood gases and lactic acid as those were needed to explain the improvement in gas exchange and to know the muscle metabolism after exercises. Advance research is neede to know the benefit of aerobic exercise by ergo-cycle on quality of life of COPD patients.

CONCLUSIONS

Thirty minutes ergo-cycle exercise for 3 times a week in 4 weeks respectively increases lung functional capacity and physical fitness level of mild and moderate COPD patients. There is a positive correlation between lung functional capacity with the physical fitness level on patients with COPD.

This study's findings show an increase in functional lung capacity and fitness levels COPD patients, it is advisable for further research to measure blood gases and lactic acid before and after exercise, to compare the effectiveness of different exercises, and to measure the quality of life for COPD patients after ergo-cycle exercise.

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