

## Effect of Treadmill Exercise Using 80% Intensity of Six Minute Walk Test on Walking Distance and Quality of Life in Moderate Stage Chronic Obstructive Pulmonary Disease Patients

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### Abstract

Skeletal muscle dysfunction poses as one of the systemic manifestation of chronic obstructive pulmonary disease (COPD) in the impact of inactivity and deconditioning from early fatigue to the end of declining quality of life (QoL). Giving pulmonary rehabilitation program of treadmill exercise will overcome the problem, but standard method for moderate stage of COPD is not yet available. This study aimed to evaluate the effect of treadmill exercise using 80% intensity of six minute walk test on walking distance and QoL in moderate stage COPD in order to overcome muscle dysfunction. Samples were taken from Physical Medicine and Rehabilitation and Respirology subdivision of Internal Medicine outpatient clinic of Dr. Hasan Sadikin General Hospital Bandung, from March 2012–April 2013. Data analysis was tested using t-test for comparison of two independent mean data. Otherwise, non parametric test of Mann Whitney and Wilcoxon Match Pair test. Thirty three subjects of moderate stage COPD were divided into 2 groups (intervention and control). Intervention group received treadmill exercise with 80% intensity from preliminary 6MWT for 30–60 minutes/session, 3 session/week for 6 weeks. Significant increase on walking distance was found in intervention group (70.66 m) compared to control group (7.43 m) after 6 weeks ( $p \leq 0.05$ ). QoL using St. George Respiratory Questionnaire (SGRQ) showed significant decrease in intervention group for all components in the end of 6 weeks (total  $p = 0.0038$ , symptoms  $p = 0.0162$ , activities  $p = 0.0043$  and impact  $p = 0.0057$ ,  $p \leq 0.05$ ). Eighty percent intensity of 6MWT in treadmill exercise for 6 weeks was well tolerated and could overcome skeletal muscle dysfunction in moderate stage COPD. It also revealed higher values in aerobic capacity and QoL compared to previous studies. In conclusion, treadmill exercise using 80% intensity of 6MWT provides further walking distance and higher QoL compared to control in moderate stage COPD. [MKB. 2016;48(2):105–11]

**Key words:** Moderate stage COPD, quality of life, treadmill exercise, 6MWD

## Pengaruh Latihan Erobik Menggunakan *Treadmill* dengan Intensitas 80% Uji Jalan 6 Menit terhadap Jarak Tempuh dan Kualitas Hidup Pasien PPOK Derajat Sedang

### Abstrak

Disfungsi otot rangka merupakan salah satu manifestasi sistemik penyakit paru obstruktif kronik (PPOK), menyebabkan penderita mengalami inaktivitas dan dekontidisi akibat kelelahan dini sehingga menurunkan kualitas hidupnya. Latihan erobik menggunakan *treadmill* merupakan modalitas dalam rehabilitasi PPOK untuk mengatasinya, namun hingga saat ini belum ada metode baku pada PPOK derajat sedang. Penelitian ini bertujuan menilai pengaruh latihan erobik menggunakan *treadmill* dengan intensitas 80% uji jalan 6 menit terhadap jarak tempuh dan kualitas hidup pada pasien PPOK derajat sedang. Penelitian ini dilakukan di Departemen Ilmu Kedokteran Fisik dan Rehabilitasi Fakultas Kedokteran Universitas Padjadjaran/Rumah Sakit Dr. Hasan Sadikin Bandung periode Maret 2012–April 2013. Naracoba berjumlah 33 orang, dibagi menjadi kelompok kontrol dan perlakuan. Latihan dilakukan dengan intensitas 80% kecepatan uji jalan 6 menit, 30–60 menit/sesi, 3x/minggu selama 6 minggu. Terjadi peningkatan bermakna jarak tempuh ( $p \leq 0,05$ ) dan penurunan nilai *St. George Respiratory Questionnaire* (SGRQ) di seluruh komponennya (total, dampak, gejala dan aktivitas,  $p \leq 0,05$ ) kelompok perlakuan dibanding dengan kontrol setelah 6 minggu latihan. Latihan erobik menggunakan *treadmill* dengan intensitas 80% kecepatan uji jalan 6 menit selama 6 minggu ditoleransi dengan baik dan dapat memperbaiki disfungsi otot rangka pada pasien PPOK derajat sedang. Simpulan, latihan erobik menggunakan *treadmill* dengan intensitas 80% dari uji jalan 6 menit memberikan peningkatan jarak tempuh dan kualitas hidup dibanding dengan kontrol pada PPOK derajat sedang. [MKB. 2016;48(2):105–11]

**Kata kunci:** Jarak tempuh uji jalan 6 menit, kualitas hidup, latihan *treadmill*, PPOK derajat sedang

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## Introduction

Chronic obstructive pulmonary disease (COPD), based on the definition from the global initiative for chronic obstructive lung disease (GOLD) 2014 is a preventable and curable disease with a persistent and progressive airflow limitation which relates to increased chronic inflammation response of airway and lung to noxious particles or gases.<sup>1</sup> In accordance with GOLD 2014, the American Thoracic Society (ATS) and European Respiratory Society (ERS) stated that COPD has a few extrapulmonary effects that depend on the severity of the disease.<sup>1,2</sup>

One of the systemic manifestations is skeletal muscle dysfunction, that is described as oxydative stressed and inflamed muscles, diminished capillary density, apoptosis, and impaired muscle regeneration capacity. Decreased lung function and disturbance of gas exchange lead to increased respiratory muscles work and decreased use of peripheral muscles. Other factors, such as the inflammation process, malnutrition, comorbid diseases, and corticosteroid consumption could also contribute to the systemic extrapulmonary effects.<sup>3,4</sup> This premature muscle fatigue happens during activities due to early anaerobic glycolysis in peripheral muscles of the lower extremities, particularly in the process of producing lactate acid. In the end, deconditioned COPD patients will limit their physical activities which will result in the reduction in quality of life (QoL).<sup>3-5</sup>

Pulmonary rehabilitation lately has been positioned as an essential approach in dealing with these problems to improve pharmacological effects, control, and to reduce symptoms and optimize the functional capacity as proven by Lacasse et al.<sup>6</sup> and Riario-Sforza et al.<sup>7</sup> These studies have shown increased independency in COPD patients. Cardiopulmonary endurance training of aerobic exercise is the fundamental component in pulmonary rehabilitation.<sup>1,3,6-8</sup>

Aerobic exercise as the primary component of the pulmonary rehabilitation that includes ambulation muscles is categorized as a grade A recommendation in several studies, including studies involving COPD patients.<sup>1,7</sup> The most common method is using treadmill as it reflects walking in daily activities. The American College for Sports Medicine (ACSM) recommendation for exercise in COPD comprises walking exercise (50–80%  $VO_{2peak}/VO_{2max}$ ) with 60–90% of predicted heart rate or attaining subjective tolerated symptoms. Probst et al.<sup>10</sup> gave 75% mean velocity from six minute walk test (6MWT) of treadmill exercise intensity to moderate and

severe-stage COPD patients for 12 weeks and obtained an increased walking distance as 44 m. Another study assigned lower intensity, 60% mean velocity of 6MWT, in 12-week treadmill intervention for severe stage COPD presenting increased walking distance below 30 m.

Treadmill-based exercise takes account of all over body movements since upper extremities are also active; hence, increases oxygen uptake compared to static ergocycle exercise that only uses the lower extremities muscles. Active plain use of lower extremities muscles has led to the finding of shortness of breath and fatigue. In addition, this exercise produces lower oxygen uptake than treadmill exercise. Longer treadmill exercise was also proven<sup>12</sup> to show higher peak oxygen uptake compared to the exercise using static ergocycle. This is seen because lactate is produced quicker.

Pulmonary rehabilitation candidates in COPD cases according to the British Thoracic Society (BTS) and ERS include moderate stage COPD with forced expiratory volume in 1 second (FEV1) less than 60% predicted value.<sup>2</sup> Meanwhile, GOLD 2014 stated that higher achieved benefit is more presentable when aerobic exercise in COPD is provided earlier in FEV1<80% predicted value.<sup>1</sup>

Six minute walking distance (6MWD) from 6MWT is recommended to be used as a standard exercise test for measuring functional capacity in COPD by the American Thoracic Society (ATS). The 6MWT's intensity is submaximal, proven to be reliable, objective, cheap, easy to perform, and tolerable for COPD patients.<sup>12</sup> This test evaluates integrated responses of lung as well as cardiovascular and musculoskeletal functions and, thus, reflects functional activity level of daily living since those are submaximal activities.<sup>2,7</sup>

The impacts of respiratory diseases in health-related QoL and well-being are measured using SGRQ or St.George's Respiratory Questionnaire which is proven valid and responsive for the determination of QoL in COPD. The validity in versions using different languages other than English are shown highly reliable and valid.<sup>14</sup> In Indonesia, aerobic exercise studies in COPD patients are limited. Saraswati et al.<sup>15</sup> measured increased functional capacity using 6MWT and significant decreased symptoms score of SGRQ in moderate stage COPD after 8 weeks of self-paced walking exercise while Ikalius et al.<sup>16</sup>, through the application of minimal-10-minute static ergocycle exercise for 8 weeks of self-paced velocity also showed significant increase in 6MWD and a decrease in SGRQ total score.

This study aimed to evaluate the effect of

treadmill aerobic exercise in walking distance and QoL of moderate stage COPD.

### Methods

This is a pre- and post-intervention randomized controlled experimental study. Samples were consecutively selected. Thirty three subjects were recruited from the Physical Medicine and Rehabilitation Department and also from the Respirology Outpatient Clinic of Dr. Hasan Sadikin General Hospital Bandung. The subjects signed informed consent before participating. This study was carried out during the period of March 2012–April 2013 and approved by ethical commission of the hospital. The subjects were divided into two groups consisted of 18 randomly-chosen subjects (intervention group, A) and 15 subjects (control, B). The inclusion criteria for the subjects were 40–65 years old, suffering from moderate stage COPD, able to understand verbal-nonverbal instruction or hand language (mini mental state examination–MMSE 24–30), stable condition with medication (bronchodilators and corticosteroids), agree to participate in the study after informed consent, and able to undergo 6MWT. The exclusion criteria were hearing impairment, history of congestive heart disease, history of diabetes mellitus, oxygen saturation less than 90%, neuromusculoskeletal impairment that precludes the study procedure, and acute exacerbation (Anthonisen criteria). A subject would dropped out of the study if he/she was unable to do a total of at least 3 exercise sessions.

Both groups received education and chest physical therapy (including breathing technique). An additional treadmill exercise was conducted by group A utilizing 80% intensity from 6MWT,

30–60 minutes/session, 3 times per week for 6 weeks. Walking distance from 6MWT and QoL measured by SGRQ were obtained before and after intervention for both groups.

Data were analyzed using t-test to compare two independent mean data. Mann Whitney non-parametric test and Wilcoxon Match Pair test were also used. A statistical software was used during the analysis with  $p < 0.05$ .

### Results

The age between the two groups (as shown in Table 1) were significantly different ( $p \leq 0.01$ ), while other variables were found homogenous. Basic data upon QoL differed through gender and education between groups were found not different (Table 2 and Table 3).

After 6 weeks of intervention, significant difference was found in 6MWD ( $p 0.00, p < 0.05$ ) with higher increased distance in group A than control (B) (Table 4). Other than that, measured QoL was found significantly different in all components between before and after intervention between group A and B (Table 5).

### Discussion

Pulmonary rehabilitation program which consists of exercise and education was proven able to provide significant improvement in maximal exercise capacity, walking distance and muscle endurance along with improved health-related QoL and improved shortness of breath and fatigue symptoms.<sup>9</sup> Higher increased mean walking distance which was found on group A (70.67 m vs control 7.43 m) compared to a study by Ikalius et al.<sup>16</sup> was bigger in number (Ikalius:

**Table 1 Subjects' Characteristics**

Variables	Group A (n=18)		Group B (n=15)		P Value*
	Average (SD)	Median (Range)	Average (SD)	Median (Range)	
Age (years old)	62.111 (3.708)	(52.0–65.0)	56.667 (7.461)	(41.0–65.0)	0.0105*
BMI	22.739 (4.916)	(14.880–30.160)	21.593 (5.451)	(16.610–35.560)	0.5305*
FEV1	58.944 (4.518)	(52.00–69.00)	57.440 (3.247)	(51.00–63.00)	0.2772*
FEV1/FVC*	0.657 (0.043)	0.67 (0.510–0.690)	0.642 (0.042)	0.60 (0.560–0.690)	0.3289**
6MWD 1	349.00 (54.484)	(240.00–425.00)	325.933(60.699)	270.00–480.00	0.2589*

Note: \*independent t-test; \*\*Mann-Whitney; 6MWD1: 6MWT distance before intervention

**Table 2 Characteristic of Gender and Educational Background**

Variables	Group A	Group B	P Value*
	(n=18)	(n=15)	
	n	n	
Gender			0.2673
Male	14	9	
Female	4	6	
Education			0.6109
Junior High School Graduates	2	2	
Senior High School Graduates	6	6	
Diploma degree	3	2	
Bachelor degree	7	5	

Note: statistics: Chi square test

intervention group 55 m vs control 3.4 m). Even compared to 52.7 m after 4-week exercise in the study of Saraswati et al.,<sup>15</sup> this present study found higher achieved mean walking distance. Other similar studies that use the same 6-week period resulted in smaller amount of increased walking distance (Zanchet et al.<sup>17</sup> 57 m; Torres et al.<sup>19</sup> 58 m).

All those results mentioned before have passed the clinical threshold to be called as a significant increase in post treatment walking distance in accordance to other study (54 m), Lacasse et al.<sup>6</sup> (50 m) and a metaanalysis study in 2006 (48 m).<sup>6</sup>

Higher results in this study due to differences in stage of severity in COPD subjects, types of exercise given, duration, intensity and frequency compared to previous studies. Moderate stage COPD was chosen as grade of muscle disfunction was obviously affecting functional ability in

daily activities.<sup>17</sup> Varieties of the given exercise was also one of the differing factor to previous studies. Studies of Zanchet et al.<sup>17</sup> which divides exercises into two kinds, static ergocycle aerobic exercise and combination of treadmill and self-paced walking exercise, showed different physiologic effect. In mild and moderate intensity treadmill exercise, findings of shortness of breath and muscle fatigue happens earlier and mostly found in static ergocycle exercise. Both occur due to differences in metabolic demands and muscles' working efficiency.<sup>11</sup>

In this study, as intensity was chosen higher, it also supported in the increased walking distance. Higher intensity means better results in COPD patients.<sup>11,18,19</sup> Seventy-five percent of 6MWT velocity intensity was applied by Probst et al.<sup>10</sup> in treadmill exercise, 60% maximum work load velocity of static ergocycle exercise, step-up-and-down stairs exercise and strengthening upper and lower extremities exercise with 70% of one repetition maximum (1RM) in moderate to severe stage COPD. These training which was done for 1.5 hours each session, 3 times per week for 12 weeks resulted in lower increase of walking distance (44 m) compared to our study which reasoned with higher intensity given (80 %) even though only for a shorter duration of aerobic exercise (30–60 minutes) for 6 weeks. Preference of shorter duration was based on several studies that describe aerobic training in COPD pulmonary rehabilitation will give good adaptational muscle change when duration of the exercise is between 30–50 minutes, 3–5 times/week for 5–10 weeks.<sup>18,19</sup>

Skeletal muscle dysfunction in COPD especially is caused by inactivity from shortness of breath during activities that reason for inactivity and deconditioning cycle and in the end causes bigger muscle impairment even to low intensity activity.<sup>3,4,11</sup> Inactivity causes structural and biochemistry changes in muscles such as decreased proportion of type I muscle

**Table 3 Differences in Quality of Life (SGRQ)**

Variables	Rank Sum Group A	Rank Sum Group 2	u	z	p Value*
Total 1	308	253	133	-0.07023	0.9424
Symptoms 1	327	234	144	-0.7593	0.4475
Activity 1	321.5	239.5	119.5	-0.5612	0.5746
Impact 1	283.5	277	112.5	-0.813	0.4158

Note: \*Mann-Whitney u test; Total 1: score of total component in SGRQ before intervention; Symptoms 1: score of symptoms component in SGRQ before intervention; Activity 1: score of activity component in SGRQ before intervention; Impact 1: score of impact component in SGRQ before intervention



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fiber; changes of type IIa to II b muscle fibers; decreased oxydative enzyme, number and density of mitochondrias; along with decreased muscle capillaries.<sup>3,4,10</sup>

Reduced muscle endurance clinically relates to exercise intolerance and decreased functional status in COPD patients. Exercise intolerance is shown in an inability to maintain duration of an activity.<sup>17</sup> Therefore, aerobic exercise in moderate stage COPD is focused on lower extremity muscles' endurance exercise with the preferred treadmill method since this will better induce increased muscle endurance for daily activities. Adapted changes in muscle happen due to proliferation of capillary to the muscle, increased

proportion of type I muscle fiber, changes from type II b to II a muscle fiber happened frequently, increased number and size of mitochondria in trained muscle group and increased oxydative enzyme responsible for oxydative phosphoric process (citrate sintethase/CS and 3-hydroxyl CoA dehidrogenase/HADH).<sup>10,18</sup>

Overcoming muscle dysfunction problem in COPD, high intensity of exercise is needed in increasing skeletal muscle aerobic capacity in the aim of increasing exercise capacity and reducing the event of shortness of breath in submaximal work load.<sup>17-19</sup> In COPD, exercise intensity is preferred the highest tolerated intensity and maintained for minimal 20 minutes. ACSM

**Table 4 Differences in Walking Distance (6MWD) Before and After 6 Weeks**

Variables	Group A (n=18)		Group B (n=15)		P Value*
	Average (SD)	Median (Range)	Average (SD)	Median (Range)	
6MWD 1	349.000 (54,484)	240-425	325.933 (60.699)	270-480	0.2588
6MWD 2	419.667 (45,466)	345-495	333.367 (49.189)	280-450	1.1643E-05
Diff distance	70.667	7.434			5.7661E-10

Note \*paired t test; 6MWD 1: distance obtained from 6MWT before intervention ; 6MWD 2: distance obtained from 6MWT after intervention

**Table 5 Differences in SGRQ Components Before and After Intervention**

Variables	Rank Sum Grup A	Rank Sum Grup B	u	z	p Value*
Diff total	386	175	55	-2.8924	0.0038
Diff symptoms	372.5	188.5	68.5	-2.4043	0.0162
Diff activity	385	176	56	-2.8562	0.0043
Diff impact	382.5	178.5	58.5	-2.7659	0.0057

Note:\*Mann-Whitney u test; differences in before and after intervention score of SGRQ in each components between group A and B

recommends above 60% of maximal work load obtained from exercise testing as intensity.<sup>13,20</sup>

Giving more than 60% maximal work load in severe stage COPD will be difficult to be tolerated and completed for a longer duration, yet different ways could be applied in moderate stage. Eighty percent intensity taken from 6MWT are well tolerated. Exercise duration early on the beginning of the study as recommended in 30 minutes, were unable to be kept in several subjects.<sup>19,20</sup> However, in this present study, researchers allowed 10–20 minutes of duration in a few early exercises since every week additional of 5 minutes was adjoined to reach target duration (30–60 minutes).<sup>13</sup>

Chronic obstructive pulmonary disease causes decreases in QoL especially in physical function, overall health standard and social function. Increased prevalence of anxiety and depression are also found in COPD compared to population in general.<sup>5</sup> The findings of improved exercise capacity after intervention in pulmonary rehabilitation will influence QoL positively and cause negative effect of walking distance changes corellated to SGRQ in activity, impact, and total components, were found related to other studies.<sup>5,14,18</sup>

Decreasing score significantly in all components of SGRQ between both groups before and after 6 weeks were found in harmony with a study by Ikalus et al.<sup>16</sup> which described significant changes in all components of SGRQ after static ergocycle aerobic exercise for 8 weeks; other study also showed similar result with pulmonary rehabilitation after 6 weeks. Different results were shown from Saraswati et al.<sup>15</sup> in which only total and impact components of SGRQ were found significantly different after self-paced walking exercise for 8 weeks.

SGRQ as a specific tool in detecting health-related QoL are proven able to evaluate degree of disability in each subject. This tool is also able to indicate how treatment should be done in each of its components in influencing outcome of psychosocial, spiritual, physical activity in COPD patient.<sup>14</sup>

Well planned pulmonary rehabilitation program may increase one's ability to perform in daily activities, increase exercise capacity, decreasing the episodes of shortness of breath, decrease experience of depression to a better overall QoL in COPD.<sup>1,2,5,6</sup> Increased exercise capacity wil then influence QoL positively and reduce scores in SGRQ in each components.<sup>18</sup> This was also shown in a study by Lacase et al.<sup>6</sup> (a metaanalysis) that illustrated decreased

shortness of breath symptoms and increased ability to perform activities in COPD patients to close up a better and increased exercise capacity and QoL. We are able to present significant increased exercise capacity that impacts in better QoL as shown in decreased score from all components of SGRQ. This study found that inuniformity in age characteristics of subjects between intervention group and control could be a bias in influencing walking distance result. In conclutions, six weeks of aerobic treadmill exercise using 80% intensity of six minute walk test provided significant further walking distance and higher QoL compared to control in moderate stage COPD.

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