Research Paper: Effects of Diaphragmatic Breathing Exercise on the Degree of Breathlessness in Patients With Chronic Obstructive Pulmonary Disease

Budiman[1*], **Sri Garnewi**[2]

1. Study Program of Public Health, Sekolah Tinggi Ilmu Kesehatan Ahmad Yani, Cimahi, West Java, Indonesia.
2. Dustira Cimahi Hospital, West Java, Indonesia.

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ABSTRACT

Objectives: The present study aimed to determine the effect of diaphragmatic breathing exercises on the degree of breathlessness among patients with Chronic Obstructive Pulmonary Disease (COPD) in West Java Province, Indonesia.

Methods: This was a quasi-experimental study with a pretest-posttest and no control group design. In total, 33 patients with COPD participated in this study using a consecutive sampling technique. The Modified Medical Research Council was used to measure the degree of breathlessness. A portable spirometer was used to assess Forced Expiratory Volume in one second (FEV1) and Forced Vital Capacity (FVC).

Results: The Mean±SD age of the study subjects was 44.5±3.17 years; 54.4% of the study participants were male, with healthy a body mass index. Approximately 42.4% of the studied patients experienced the fourth degree of breathlessness before the intervention. There was a reduction in the Mean±SD score of breathlessness from 3.42±0.53 to 1.64±0.13 after the intervention (P=0.001). There were improvements in the breathing frequency (Mean±SD: 11.8±4.9 vs 9.5±1.6), oxygen saturation (93.39±3.20 vs 95.47±4.21), and FEV1/FVC (0.5±0.12 vs 0.3±0.45) in the study subjects.

Discussion: It is expected for the hospital, educational institutions, nurses, and patients to be able to apply diaphragmatic breathing exercises as one form of nursing care measure. This is because it is proven effective to reduce the degree of breathlessness.

*** Corresponding Author:**
Budiman, PhD.
Address: *Study program of Public Health, Sekolah Tinggi Ilmu Kesehatan Ahmad Yani, Cimahi, West Java, Indonesia.*
Tel: *+62 (226) 63162224*
E-mail: *budiman_1974@yahoo.com*

Highlights

- Breathing exercises, like diaphragmatic breathing impact some individuals with COPD.
- Diaphragmatic breathing reduced breathlessness in patients with COPD.
- There were improvements in breathing frequency, oxygen saturation, and others lung functions (FEV1/FVC) in the study subjects.

Plain Language Summary

Patients with Chronic Obstructive Pulmonary Disease (COPD) commonly complain of breathlessness. It could increase anxiety and sleep disorders, and reduce their quality of life. Breathing exercise is a therapy to minimize and control the shortness of breath in patients with COPD, like diaphragmatic breathing exercise. The patient was supposed to be in a Semi-Fowler's position in which chest expansion and diaphragmatic breathing are used. Diaphragmatic breathing is a breath-holding technique; in this method, one breathes from functional residual capacity to total lung capacity while holding breath for 3 seconds. The patient was instructed to place the shirt collar a little higher, stand up straight with shoulders relaxed, and attempt to raise the chest a little. After the patient exhaled, they were instructed to breathe out through the mouth. These techniques are beneficial for lung capacity and breathlessness.

1. Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a major public health issue worldwide, and in Indonesia [1]. COPD prevalence was estimated to be 3.7% and the induced morbidity rate was equal to 35% [2]. COPD is characterized by the disturbance of gas exchange, inefficient airways, changes in breathing habits, the avoidance of movement, nutritional deficiencies, and anxiety [3]. Breath shortage is a common complaint that often requires emergency treatment; however, its severity and extent may generate extreme chest pain caused by acute physiological conditions [4]. The severe degree of shortness of breath might complicate the activity. Breathlessness is associated with the symptoms of depression, anxiety, exhaustion, sleeping disorders, discomfort [5], and reduced Quality of Life (QoL) [6]. Therefore, this population necessitates intensive treatment, including measures to reduce the degree of breathlessness [7].

Breathing exercise is among the interventions to minimize and control the shortness of breath in patients with COPD. Different types of breathing exercises have been recommended to decrease lung hyperventilation, as well as improve respiratory muscle function, exercise tolerance, and QoL in patients with COPD [8]. Breathing by the diaphragm muscles is achieved by diaphragm breathing or steady and deep breathing [8]. The effects of Diaphragmatic Breathing Exercises (DBE) between studies are reported as inconclusive [9, 10]. For instance, DBE has been suggested to improve endurance exercise and QoL in a systematic review [10]. Diaphragmatic breathing is beneficial, compared to other forms of breathing; it requires further oxygen to penetrate the lungs, i.e., around 1.5 to 2 times higher than normal breathing [3]. Conversely, the literature revealed contradictory effects of DBE on dyspnea and ventilation [9]. Nevertheless, the effects of DBE have been inferred from a single study (Holland et al.'s study) and the literature review, without assessing the validity of the included studies. However, the effects of DBE were reported to be inconsistent among various investigations [9, 10]. Therefore, this study aimed to determine the effects of DBE on the degree of tightness in patients with COPD.

2. Methods

This was a quasi-experimental study with a pretest-posttest and no control group design. The effectiveness of the provided treatment was assessed by comparing the pretest and posttest values [11]. This study was performed at an inpatient department of a general public Hospital in West Java Province, Indonesia from March 2019 to August 2019. Averagely, in this hospital, there were about 112 hospitalized patients diagnosed with COPD during the study course. This study was approved by the Institutional Review Board at the affiliated university.

In total, 33 patients with COPD were selected using a minimum calculation formula based on a quasi-

experimental design study with the values of Zα=1.96; Zβ=1,282; S=0.06; X1-X2=2.29 (S & X1-X2 were obtained from a previous study). The study subjects were selected by a consecutive sampling technique. The inclusion criteria were an age of >18 years, being diagnosed with COPD, i.e., confirmed by medical records, patients with stable conditions, ability to perform DBE, and willingness to participating in the research. The exclusion criteria were patients who failed to continue or complete DBE, presenting comorbidities, such as asthma, post-pulmonary TB obstruction syndrome, extreme static hyperinflation, and mechanical diaphragm disadvantage by promoting further asynchronous or paradoxical breathing (i.e., Hoover sign), or a history of pulmonary TB, heart diseases, kidney failure, uncontrolled DM, and severe hypertension.

We applied the Modified Medical Research Council (MMRC), developed by Mayer and Doherty to measure the degree of shortness of breath, consisting of 0-4 degrees of shortness of breath. A portable spirometer was used to assess Forced Expiratory Volume in one second (FEV1) and Forced Vital Capacity (FVC) according to the American Thoracic Society/European Respiratory Society criteria.

DBE was performed by the research participants for 2 weeks. The study participants were instructed to perform 3 sets of 5 deep breaths a day with the therapist delivering the 4 doses during the same interval. The provided DBE included 8 steps, as follows: 1) assist the study participants to sit as comfortably as possible; then, advise them to relax the muscles of the neck and shoulders. 2) Request the participants to place hands opposite to each other, below, and along the lower border of the anterior rib cage. The right hand is placed on the chest wall under the clavicle and the left hand is placed on the umbilicus, or it can be conducted otherwise. Place the tips of the third fingers of both hands by touching each other. 3) Request the research participants to slowly take a deep breath for 2 seconds, and breathe through the nose. Tell the study participants to notice that during inhalation, the two middle fingers are separated. 4) Note to the research participants that the chest and neck should not be used while inhaling. When breathing, the stomach of the study participants has to move against their hands. 5) The study participants ' chest must remain still. They must be aware that the stomach muscles are coming in. 7) Explain to the study participants that they should again touch their two middle fingertips. 8) Repeat the above-mentioned steps until the research participants feel comfortable or breathless. The relevant outcomes were measured before and immediately after the first treatment session (pretest & posttest); the obtained data were compared during normal resting breathing and diaphragmatic breathing.

Data processing was performed starting from the editing, scoring, coding, data entry, cleaning, and tabulating stages. A univariate analysis using frequency distribution and the percentage was used to describe the degree of the shortness of breath in the explored patients with COPD before and after performing DBE. The relevant results indicated that the achieved data were normally distributed. The difference between the shortness of breath before and after the intervention was examined using a t-test. All statistical tests were performed in SPSS v. 23.

3. Results

A total of 33 subjects participated in this study. The Mean±SD age of the study samples was 44.5±3.17 years. 54.4% were males with a normal body mass index. About 72.7% of the study subjects had previously smoked. The Mean±SD value of FEV1 was 32.8±11.3, the FEV1/FVC was measured as 0.5±0.12, and Peak Expiratory Flow Rate (PEFR) was computed as 5.83± 2.1 in the study participants (Table 1).

There was a significant difference between pretest and posttest values (during diaphragmatic breathing) concerning the degree of breathlessness (3.42±0.43 vs 1.64±0.13), breathing frequency (11.8±4.9 vs 9.5±1.6), oxygen saturation (93.39±3.20 vs 95.47±4.21), and FEV1/FVC (0.5±0.12 vs 0.3±0.45) in the study subjects (Table 2). However, there was no significant difference between the pretest and posttest values during normal resting breathing for all outcomes in the study participants.

Figure 1 shows the degree of breathlessness before and after the intervention. Before the intervention, approximately 19 (58%) subjects experienced the degree of breathlessness in grade 3, and 8 (24%) encountered the degree of breathlessness in grade 4. After the intervention, 20 (1%) individuals experienced the degree of shortness in grade 2, 5 (15%) grade 3, and 8 (24%) grade 4.

4. Discussion

Almost all patients with COPD experienced shortness of breath with degrees 4 to 5. Our study data indicated a higher degree of breathlessness, compared to a study conducted by Vitaloka and Alamsyah in patients with COPD [12, 13]. Shortness of breath is among the complaints that often require emergency treatment; however, its intensity and level can be associated with serious

Table 1. The characteristics of the study participants

Characteristics		Values
Age, Mean±SD (y)		44.5±3.17
Gender, No. (%)	Male	18 (54.5)
	Female	15 (45.5)
	BMI, Mean±SD (kg/m^2)	23.2±2.8
Smoking history (past 6 months), No. (%)	Yes	24 (72.7)
	No	9 (27.3)
	FEV1, Mean±SD, % predicted	32.8±11.3
	FEV1/FVC, Mean±SD	0.5±0.12
	MMRC score, Mean±SD arbitrary units	3.42±0.43
	PEFR	5.83±2.1

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Note: BMI: Body Mass Index; FEV1: Forced Expiratory Volume in one second; FVC: Forced Vital Capacity; MMRC: Modified Medical Research Council

chest discomfort. The further the degree of the shortness of breath, the more difficult for the patient to perform the activity, and the greater the activity intolerance, nutritional deficiencies, and feelings of fear. Breathlessness is associated with the symptoms of de-pressure, anxiety, exhaustion, sleeping problems, discomfort [5], and reduced QoL [6]. Several characteristics can affect the severity of the degree of shortness of breath in patients with COPD, such as age, gender, and smoking habits.

One form of breathing exercise that can be provided to patients with COPD to reduce the degree of shortness of breath is to DBE. According to Windarti, administrating DBE can improve patients' QoL. Accordingly, it is associated with the emergence of episodic symptoms in patients, such as shortness of breath, chest feeling heavy, and coughing [14].

This study reported that DBE could decrease breathlessness. The obtained results were consistent with those of Vitaloka; it explained the effects of respiratory muscle exercises through DBE on decreasing the degree of shortness of breath in patients with COPD [12]. These data were also in line with the research conducted by

Table 2. Comparing the degree of breathlessness and other lung function parameters before and after performing DBE

Outcome	Pretest	Posttest	
		During Diaphragmatic Breathing (Mean±SD)	During Normal Resting Breathing (Mean±SD)
Degree of breathlessness	3.42±0.43	1.64±0.13***	3.16±1.73
Breathing frequency, breaths/min	11.8±4.9	9.5±1.6***	12.1±2.91
Oxygen Saturation, %	93.39±3.20	95.47±4.21***	93.21±3.46
FEV1/FVC	0.5±0.12	0.3±0.15***	0.5±0.16
FEV1, % predicted	32.8±11.3	30.1±9.43	31.5±7.71
Peak Expiratory Flow Rate	5.83±2.1	5.62±1.8	5.51±2.0

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Note: BMI: Body Mass Index; FEV1: Forced Expiratory Volume in one second; FVC: Forced Vital Capacity; MMRC: Modified Medical Research Council. ***P<0.005

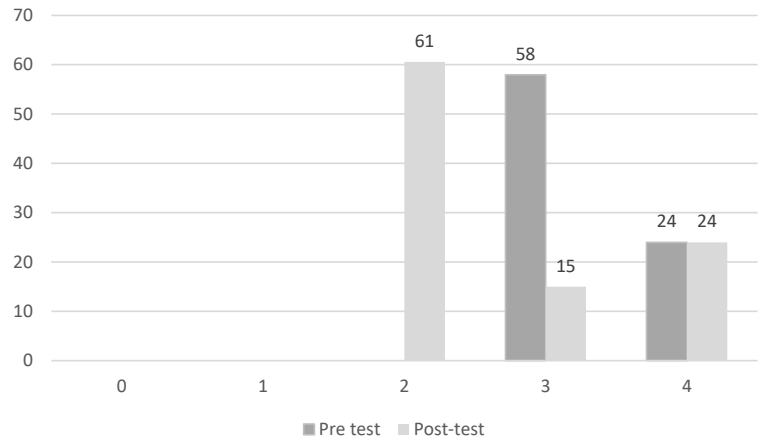

Figure 1. The degree of breathlessness before and after the intervention

Alamsyah; it concerned the effects of breathing exercises on the degree of shortness of breath in patients with COPD [13]. According to Mayuni et al., repeated and routine diaphragmatic breathing helps with correctly using the diaphragm when breathing [14]. This technique is useful to strengthen the diaphragm and decrease respiratory work by reducing the rate of breathing, using less effort and energy to breathe. Diaphragmatic breathing increases tidal volume, decreases functional residual capacity, and enhances optimal oxygen uptake.

DBEs are a combination of chest and abdominal breathing; they aim to relax the breathing muscles while performing deep inspiration. Patients concentrate on efforts to develop the diaphragm during controlled inspiration [15]. According to Windarti, diaphragmatic breathing exercises aim to improve breathing function, as well as train and regulate breathing by breathing properly. This technique is employed if an individual experiences sudden shortness of breath symptoms [16]. Additionally, DBEs aims to improve circulation and flex and strengthen the breathing muscles. According to Sudoyo, DBEs aim to reduce the feeling of shortness of breath with exercises that focus on abdominal breathing [7]. Nurses need to assist patients to achieve independence by providing diaphragmatic breathing exercises through health education.

This study had some limitations. We disregarded a control group; thus, another covariate that may have affected the cognitive change was not measured. Second, we did not follow up on the outcomes; thus, it may affect the short effects of the provided intervention; considering the relevant long-term effects is required for future studies to investigate.

5. Conclusion

In conclusion, DBEs could reduce the degree of shortness of breath experienced by patients with COPD. Nurses can provide health education to teach patients to be able to perform DBEs when feeling shortness of breath. Future studies using rigor methods and large sample sizes are required to evaluate the precise effects of DBEs to reduce the symptoms in patients with COPD and improve their QoL.

Ethical Considerations

Compliance with ethical guidelines

There were no ethical considerations to be considered in this research.

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Authors' contributions

Both authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflicts of interest.

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