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Combination of diaphragmatic breathing with therapeutic walking exercise to increase peak expiratory flow rate in asthma patients

Original Article

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Abstract: **Objective:** This study aimed to determine the effect of combined diaphragmatic breathing and therapeutic walking exercise on peak expiratory flow in asthma patients.

Methods: The research design used a quasi-experiment nonequivalent pretest and posttest design. The research sample contained 38 respondents divided into intervention and control groups, selected by simple random sampling. The control group received standard drug therapy, while the intervention group received standard drug therapy and a combination of diaphragmatic breathing and therapeutic walking exercise for 2 weeks. This exercise was carried out in the morning, 6 times a week, with 5 diaphragmatic breathing and exhalations per exercise. After that, a 1-min break was followed by a therapeutic walking exercise of 5–15 min, with an increased duration. Both groups measured the peak expiratory flow before and after the intervention using a peak flow meter. The data analysis used central tendency and *t*-test.

Results: The results showed that the mean peak expiratory flow in the intervention group was 306.84, while in the control group, it was 232.63, with the value of the *t*-test being –14.17 ($P < 0.0001$).

Conclusions: Diaphragmatic breathing and therapeutic walking exercise significantly increased the peak expiratory flow in asthma patients.

Keywords: *asthma • diaphragmatic breathing • peak expiratory flow • therapeutic walking exercise • walking exercise*

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1. Introduction

Asthma is one of the leading health problems in both developed and developing countries, affecting all age groups. The global prevalence among adults experiencing severe wheezing episodes within a year reached 21%. The 2019 Global Initiative for Asthma (GINA) report stated that asthma incidence in various countries was 1%–18%.[1] The 2015 Global Burden of Disease study disclosed data that the incidence has increased by 12.6% from 1990 to 2015.[2] According to the World Health Organization (WHO), in 2016, 235 million people were affected by asthma and the condition was underdiagnosed, with a mortality rate of 80% in developing countries.[3] Although

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some countries have experienced a decrease in asthma-related hospitalizations and deaths, the global burden for patients from daily exacerbations and symptoms has increased by 30% in the past 20 years.[1]

According to *Riset Kesehatan Dasar* (RISKESDAS),[4] in 2018, asthma prevalence in Indonesia was 4.5%. Specifically, the incidence of asthma in West Nusa Tenggara Province reached 46,789 cases in 2015 and was included among the top 10 diseases.[4] Meanwhile, asthma patients in Central Lombok Regency numbered 8,992 and it ranked third among the top 10 diseases. The results of a preliminary study in 2017 at Mujur Health Center revealed that the number of adult asthma sufferers reached 142.

According to the Indonesian Ministry of Health (2018), asthma is one of the top 10 causes of death and illness and is estimated to increase by 20% in the next 10 years if it is not adequately controlled.[4] Well-controlled asthma is a goal of long-term asthma management. The frequency of asthma recurrence is one indicator of asthma control. However, the case presentation of asthma patients requiring acute attack management did not significantly change from 1998 to 2009; only 2% change was seen, decreasing from 36% to 34%.[5]

Research by Ferliani et al.[6] confirmed that even though patients in Indonesia were given standard therapy, the number of people with uncontrolled asthma with the frequency of asthma recurrence was still high, about 51%–59% of the total patients. Priyanto et al.[7] reported 4 reasons for treatment nonadherence among asthma patients. These reasons were as follows: 9.8% of respondents could not tolerate drug's side effects, 9.8% due to expensive examination fees and drugs, 8.82% felt no improvement after treatment, and 14.71% thought that the treatment place was too far away.[7] Moreover, other studies concluded that the therapy cost[8,9] also influenced effective and rational therapy for asthma management.

Asthma management is in the form of pharmacological and nonpharmacological therapies to relieve symptoms and reduce recurrence.[10,11] Pharmacological treatment for asthma is with drugs, and nonpharmacological means of treatment can be in the form of breathing exercises and physical activity.[12–14] Diaphragmatic breathing exercises constitute the primary breathing exercise therapy for asthma patients. Diaphragmatic breathing exercises can result in CO_2 being released from the lungs, reducing the work of breathing and increasing ventilation. Increased ventilation leads to increased perfusion, favorable intra-alveolar pressure, and adequate gas exchange. It causes the degree of acidity (pH value) to decrease so that CO_2 in the arteries decreases and peak expiratory flow rate (PEFR) increases.[15] Apart from improving respiratory function, breathing exercises can maintain the immunoglobulin E (IgE) balance in the bronchi and reduce excessive responses from the respiratory tract.[16]

Physical activity improves the quality of life and lung condition of asthma patients.[17] The type of physical activity is therapeutic walking exercise.[18] Prior research results showed that doing therapeutic walking exercises 12 times carried out 6 times a week[18–20] (other research implemented 24 weeks of exercise intervention)[21] resulted in a significant difference in the PEFR. One of the breathing exercises that can be given is diaphragmatic breathing. Moreover, Kartikasari et al.[16] found that 2-week diaphragmatic breathing exercises increased peak expiratory flow. This study aimed to examine the effect of combination therapy of diaphragmatic breathing and therapeutic walking exercise on asthma patients' peak expiratory flow.

2. Methods

2.1. Design

This study used a quasi-experimental nonequivalent pre–post test design. The intervention group was given standard drug therapy and combination therapy of diaphragmatic breathing with therapeutic walking exercise. Meanwhile, the control group was assigned standard drug therapy from the primary health center. The research was conducted in 2 villages of Mujur Health Center working area—Marong village for the intervention group and Mujur village for the control group. Marong and Mujur villages are 2 areas with the highest incidence of asthma in the Mujur Health Center area. The study was carried out for 2 weeks in December 2019. Sample size calculation used the formula for 2 independent means with 2-sided significance level α=0.05 and power $1 - \beta = 0.8$. Thus, the study sample comprised 38 respondents: 19 respondents in the intervention group and 19 in the control group. Randomization was used to determine the individuals assigned to the intervention and the control groups. The technique used simple randomization by flipping a coin.

2.2. Inclusion and exclusion criteria

The inclusion criteria were as follows: patients with mild and moderate asthma (categorization of asthma was based on the level of symptom, airflow limitation, and lung function variability according to the Global Initiative on Asthma), willing to be respondents, aged 20–55 years (asthma prevalence in outpatients based on age in Indonesia is highest at the age of 25–55 years, which is 24.05%), and asthma clients with routine standard medical therapy (salbutamol and prednisone). Meanwhile,

the exclusion criteria included asthma patients whose condition required hospitalization, asthmatic patients with physical limitations, asthma patients with heart disease, and patients with exercise-induced asthma.

2.3. Intervention

The intervention combined diaphragmatic breathing with therapeutic walking exercises in the intervention group for 2 weeks. This exercise was carried out once a day in the morning, given 6 times a week for 2 weeks. One regimen comprised 5 diaphragmatic breathing in and out in 1 exercise and therapeutic walking exercise for 5–15 min. The duration would be increased by 5 min after every 4 exercises. Meanwhile, the control group would still receive standard therapy from the health center, and the health center would monitor their health condition during the study. Researchers assessed the peak expiratory flow and asthma recurrence (presence of symptoms such as wheezing, shortness of breath, heavy chest, and coughing) in the intervention and control groups after the 12th treatment.

A Vilalograph peak flow meter was used to measure the PEFR. The results were recorded if the participants exerted maximum effort during the test. PEFR measurements were carried out by 2 senior nurses who had received approved training and undertaken supervised practice. However, to ensure that the method and the results are the same, the researcher developed a standard operating procedure for using the peak flow meter. Peak flow rates are interpreted using three zones of measurement. The three zones (categories) are distinguished based on the percentages of predicted flow rates: green (flow rates <50%), yellow (flow rates between 50% and 80%), and red (flow rates >80%). The instrument used to measure asthma recurrence frequency was asthma recurrence frequency observation.

3. Results

The respondents' characteristics indicated that the respondents' age range was in the late adult and early elderly categories. Most of the respondents in the intervention group were late adults, while the control group was mainly in the early elderly class. The respondents' gender was primarily female, the most common occupation was farming, and most respondents' last education was Senior High School in the intervention and control groups. Considering the body mass index (BMI) characteristics, the intervention group had respondents in the underweight, normal, overweight, and obese I categories. In the control group, most respondents were in the normal BMI category. The results of the chi-square tests on characteristics revealed that there was no difference between the intervention and control groups ($P > 0.05$) (see Table 1).

The combination intervention of diaphragmatic breathing exercises with therapeutic walking exercises in the intervention group showed that the PEFR pretest value was in the red zone of the peak flow meter, and the posttest PEFR revealed an increase in the intervention group, namely, switching of the category to the yellow area. Meanwhile, in the control group, the PEFR pretest scores were in the red zone, and the PEFR posttest scores had an average increase but were still in the red area (Table 2).

The analysis results with the dependent *t*-test showed that the *P* value <0.0001. It could be concluded that the combination therapy of diaphragmatic breathing exercise with therapeutic walking exercise could increase peak expiratory flow. The mean difference is –74.21, standard error difference is 5.23, 95% confidence interval (CI) is –21.24, $P = 0.0001$ (*P*-value <0.05 based on independent *t*-test).

4. Discussion

A recent study found an effect of combination therapy of diaphragmatic breathing with therapeutic walking

Characteristics	Intervention group ($n = 19$), *n* (%)	Control group ($n = 19$), *n* (%)	*P*-value*
Age			0.328
Late adult	10 (52.6)	7 (36.8)	
Early elderly	9 (47.4)	12 (63.8)	
Gender			0.631
Male	3 (15.8)	2 (10.5)	
Female	16 (84.2)	17 (89.5)	
Occupation			0.589
Housewife	8 (42.1)	9 (47.4)	
Farmer	10 (52.6)	10 (52.6)	
Entrepreneur	1 (5.3)	0	
Highest level of education			0.671
No school	2 (10.5)	1 (5.3)	
Elementary school	5 (26.3)	3 (15.8)	
Junior high school	2 (10.5)	4 (21.1)	
Senior high school	10 (52.6)	11 (57.9)	
Body mass index			0.345
Underweight	1 (5.3)	0	
Normal	7 (36.8)	12 (63.2)	
Overweight	7 (36.8)	5 (26.3)	
Obese	4 (21.1)	2 (10.5)	

Note: *$P < 0.05$ based on chi-square test.

Table 1. Participants' sociodemographic characteristics (*N*= 38).

Variable	Intervention group (n = 19)			Control group (n = 19)		
	Min–max	Mean ± SD	*P*-value*	Min–max	Mean ± SD	*P*-value*
Pre test PEFR	190–250	216.32 ± 17.71	0.0001	190–230	205.79 ± 12.16	0.0001
Post test PEFR	280–350	306.84 ± 19.45		210–250	232.63 ± 11.94	

Note: min–max, minimum–maximum; PEFR, peak expiratory flow rate; SD, standard deviation.
**P*-value <0.05 based on dependent *t*-test.

Table 2. Effect of the combination of diaphragmatic breathing exercise with therapeutic walking exercise on PEFR (N = 38).

exercise on peak expiratory flow in the intervention group. It is in accordance with Udayani et al.'s[22] research, which proved that a combination of physical walking and breathing exercises complement pulmonary rehabilitation, which could increase the peak expiratory flow value in asthma patients.[22,23]

Furthermore, Kartikasari et al.'s[16] research revealed an increase in PEFR in the second week. Breathing using the diaphragm muscle was better than breathing using the intercostal muscles. Diaphragm breathing exercises increase the expiratory muscles so that they remove the air trapped in the lungs. The diaphragm muscles become flattened at the time of inspiration, giving the lungs more room for expansion. Air enters the lungs, and the stomach expands due to the diaphragm muscles' use when doing diaphragmatic breathing exercises. The abdominal muscles help release air during expiration and provide more force to empty the lungs so that expiratory power increases, and the PEFR increases after exercise. The maximum expiratory flow was much higher when the lungs were filled with a large air volume than when the lungs were almost empty.[24,25]

After completing diaphragmatic breathing, the patients then proceeded with therapeutic walking exercises. This physical activity aimed to increase CO_2; increasing CO_2 causes dilatation of the smooth muscle in the walls of the bronchi, bronchioles, and alveoli so that there is a balance between perfusion and ventilation.[26] Other researchers proved that therapeutic walking exercises for 2 weeks could increase peak expiratory flow; this therapy increased the maximum oxygen volume and improved aerobic and anaerobic work capacity.[27,28]

According to Reid et al.,[29] muscle cooperation was marked by changes in muscle strength, muscle fatigue, muscle flexibility, reaction speed, agility, movement coordination, and cardiorespiratory system resistance when doing therapeutic walking exercises. During physical activity, the muscles experience hypertrophy, increasing the number of fibers in the muscles, the number of myofibrils, mitochondrial enzymes increase up to 120%, the muscle metabolic system components by 60%–80%, glycogen reserves by 50%, and triglyceride reserves by 75%–100%. These changes increase the aerobic and anaerobic systems' ability, significantly increasing the maximum oxidation and the oxidative metabolic system's efficiency by 45%. The muscle metabolic system's efficiency was influenced by smooth blood circulation throughout the body in supporting the muscles' metabolic processes during physical exercise, including the respiratory muscles.[29,30]

During physical exercise, there are contractions in the skeletal muscles, which compress blood vessels throughout the body. Moreover, sympathetic nerve endings in the muscle tissue release norepinephrine, constricting veins and arterioles. As a result, blood is transferred from the peripheral vessels to the heart, and the lungs would increase the cardiac output. At the same time, the hypothalamus stimulates the anterior pituitary to release epinephrine and norepinephrine systemically through both the adrenal medullae. Epinephrine that is circulated systemically to the heart binds to β1-receptors so that it increases cardio acceleration; then, the heart pumps more blood to the muscles to support aerobic metabolism.[31]

Furthermore, the work of the large muscles, such as the knee extensor muscles (quadriceps), hip extensor (hamstrings and gluteal muscles), and lower muscles (gastrocnemius and soleus in the back, tibia anterior, and Achilles muscles in the leg), when walking helps pump blood back to the heart, thereby increasing blood circulation, muscle endurance, and dynamic balance.[32]

The therapeutic walking activity could also open the arteries, increase arteries' flexibility, encourage circulation in the back of the legs and abdominal area, encourage the small blood vessels in the legs to redirect blood around the blocked arteries, and increase fat burning to reduce low-density lipid (LDL) in the blood so that the red blood cells could carry more oxygen to flow throughout the body smoothly. Improved blood flow and oxygen diffusion reduce cell hypoxia so that symptoms of shortness of breath are reduced.[18] The therapeutic walking activity also increases the functional capacity of patients with respiratory disorders, and the patient can travel certain distances without causing shortness of breath.[33,34]

In this study, the increase in PEFR value also occurred in the control group. Asthma is a chronic disease, so it requires regular treatment. One of the asthma medications is the reliever group used to relieve asthma symptoms. This drug group is recommended to prevent bronchoconstriction. The drugs used are inhaled corticosteroids, β2-adrenergic agonists, anticholinergics, and anti-IgE.[35] Asthma therapy's goal is to control symptoms and avoid death from asthma.[36]

5. Conclusions

This study's findings indicated an increase in the PEFR in the intervention and control groups. The mean value of the peak expiratory flow in the control group was higher. Moreover, there were differences in the peak expiratory flow between the values in the intervention group before and after the combination therapy of diaphragmatic breathing and therapeutic walking exercises. Combination therapy of diaphragmatic breathing with therapeutic walking exercise can be adopted to increase asthma patients' peak flow value.

Ethics approval

This research was approved by the Health Research Ethics Commission of Universitas Aisyiyah Yogyakarta (No. 1315/KEP-UNISA/XI/2019).

Conflicts of interest

All contributing authors declare no conflicts of interest.

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