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Active Cycle Of Breathing Technique (ACBT) Improves Lung Function in Tuberculosis Patients

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ABSTRACT

Background: pulmonary tuberculosis causes permanent structural damage to lung tissue through chronic inflammation and fibrosis, which leads to decreased lung elasticity, airway narrowing, and impaired gas exchange, which are the basis for the decline in lung function. One of the promising rehabilitation techniques is the Active Cycle of Breathing Technique. **Objective:** this study aims to determine and analyze the effect of administering the Active Cycle of Breathing Technique on the lung function of pulmonary tuberculosis patients. **Methods:** quantitative research using a Quasi-Experimental research design with a pre-test-post-test control group design, the sampling technique in this study used purposive sampling in 60 people. The instruments using observation sheets of lung function measurement results. Data analysis used the Wilcoxon signed rank test. **Results:** the study showed that there was an effect of administering the Active Cycle of Breathing Technique on pulmonary function of tuberculosis. The results of the Wilcoxon signed rank test statistical test showed an effect of the ρ value in the treatment group of 0.000 (α <0.05). **Conclusion:** these findings suggest that administering Active Cycle of Breathing can improve lung function in tuberculosis patients. This study emphasizes that pharmacological therapy alone without additional respiratory rehabilitation interventions is insufficient to optimize lung function improvement.

Keywords: Active Cycle of Breathing Technique; Pulmonary Function; Pulmonary Tuberculosis

Background

Pulmonary tuberculosis (TB) causes permanent structural damage to lung tissue through chronic inflammation and fibrosis, resulting in decreased lung function. Although anti-TB treatment successfully cures active infection, its impact on lung function often shows long-term decline or worsening in TB patients. Recent research confirms that without pulmonary rehabilitation intervention, respiratory function in TB patients post-TB treatment tends to deteriorate, with more than 25% of patients showing moderate to severe impairment despite completing treatment. Active Cycle of Breathing Technique (ACBT) improves the effectiveness of airway clearance in patients with pulmonary tuberculosis. The combination of ACBT with chest physiotherapy resulted in a significant increase in airway clearance scores (1)(2).

Globally, TB is the leading cause of death in the world due to a single infectious agent and is included in the top 10 causes of death, in 2024 an estimated 10.7 million people are infected with TB worldwide including 5.8 million men 3.7 million women and 1.2 million children. Indonesia faces a high burden of pulmonary TB, with East Java Province ranking second as the province with the highest number of cases. Based on data from the Health Office on the tuberculosis situation for the period January-December 2024, in Gresik Regency, 3,404 cases were recorded in 2024 and 4,740 new TB patients in 2025, which shows an increase of 39% in case discovery through the TB control program (3).

The process of tuberculosis (TB) begins with the inhalation of Mycobacterium tuberculosis bacteria into the respiratory tract, which are then taken up by alveolar macrophages in the lungs. Granulomas form as the body's response to contain the infection, but these granulomas also cause inflammation and lung tissue damage, disrupting normal lung function (4). In advanced stages, ongoing inflammation and the activity of proteolytic enzymes such as matrix metalloproteinases (e.g., MMP-1) lead to more extensive lung tissue degradation, including cavity formation and fibrosis. An excessive immune response, particularly the activation of M1 macrophages and neutrophils, exacerbates tissue damage through necrosis and structural remodeling of the lungs. This leads to decreased lung elasticity, airway narrowing,

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and impaired gas exchange, which underlie the decline in lung function (5).

Research result, showed that overall lung function in the post-TB group was worse than the control group, with obstructive disorders being more common in post-TB patients than in controls (6). Although OAT successfully cures active infection, its impact on lung function often shows long-term decline or worsening in TB survivors. Post-Tuberculosis Obstructive Syndrome (PTOS) is characterized by a significant decline in lung function, with FEV1 more affected than FVC (7).

The relevance of this research lies in the fact that pulmonary TB often leaves impaired lung function that is not fully resolved by standard treatment, thus requiring non-pharmacological interventions such as ACBT to prevent decreased quality of life and the risk of complications. Based on the problem description and theory above, the researchers are interested in conducting research on the Effect of Active Cycle of Breathing Technique (ACBT) on Lung Function in TB Patients.

Methods

This type of research is a quantitative study using a Quasi-Experimental research design with a pre-test-post-test control group design. This design is to compare two groups (treatment & control) and measure changes in lung function before (pretest) and after (posttest) the ACBT intervention, with the main objective of analyzing the impact of the intervention. Respondents in this study were divided into two groups: the treatment group and the control group. The purpose of this study was to determine and analyze the effect of administering Active Cycle of Breathing Technique (ACBT) on lung function in TB patients.

The population in this study were all TB patients in the Manyar Community Health Center (UPT). Sample selection in this study was carried out using the Non-Probability sampling technique through the Purposive sampling method. The inclusion criteria in this study were TB patients undergoing intensive or advanced phase treatment, aged 18-60 years, patients in hemodynamically stable condition and not experiencing acute respiratory distress, patients not experiencing hearing and vision disorders. The exclusion criteria in this study were TB patients with severe complications, patients with other significant lung diseases, patients with unstable cardiovascular disease, patients with neuromuscular disorders. Obtained by the Chocrane formula, the sample needed in the study was 60 respondents. The sample will be divided into 2 groups so that the sample size in the treatment group was 30 respondents, and the control group was 30 respondents. The independent variable in this study was Active Cycle Of Breathing (ACBT). The dependent variable in this study was lung function in TB patients.

The instruments used to measure lung function are PEF (Peak Expiratory Flow), pulse oximetry, and respiratory rate (RR). Observation sheet showing lung function measurement results. Analysis to determine the effect of changes in lung function in TB patients between the treatment group and the control group after the intervention was calculated using SPSS statistical tests. The data in the study were tested for normality using the Kolomogorov-Smirnov test. And the data were not normally distributed. Therefore, the statistical test to determine the effect of Active Cycle of Breathing Technique (ACBT) on lung function in TB patients used the Wilcoxon signed rank test.

Results

Table 1. Demographic data characteristics of TB patient respondents

Characteristics Respondents	Treatment Group		Control Group	
	Frequency (F=60)	Precentages (%)	Frequency (F=60)	Precentages (%)
Age				
18- 59 Years	26	43,3	26	43,3
>60 Years	4	6,6	4	6,6
Type Sex				
Man	22	36,6	18	30,0
Woman	8	13,3	12	20,0
Last Education				
Not Attending School	0	0,0	1	1,6

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Characteristics Respondents	Treatment Group		Control Group	
	Frequency (F=60)	Precentages (%)	Frequency (F=60)	Precentages (%)
Elementary School	1	1,6	6	10,0
High School	19	31,6	15	25,0
Junior High School	5	8,3	6	10,0
College	5	8,3	2	3,3
Job				
Doesn't Work	4	6,6	4	6,6
Housewive	8	13,3	6	10,0
Self- employed	8	13,3	4	6,6
Laborer	10	16,6	16	26,6

Based on table 1, it shows that the age of respondents in the treatment group and the control group were partly in the 18-59 years age category, with 26 people (43.3%) and 26 people (43.3%) respectively. The gender of respondents in the treatment group and the control group was partly male, with 22 people (36.6%) and 18 people (30.0%) respectively. The education of respondents in the treatment group was partly high school (19 people) and in the control group was partly high school (15 people) 15 people (25.0%). The occupation of respondents in the treatment group was partly laborers, with 10 people (16.6%), while the occupation of respondents in the control group was half of the total number of respondents, with 16 people (26.6%).

Table 2. Statistical Test Results of Lung Function Before and After Active Cycle of Breathing Technique (ACBT) Intervention

Lung Function Categories	Treatment Group				Control Group			
	Pre Test		Post Test		Pre Test		Post Test	
	F	%	F	%	F	%	F	%
Normal	0	0%	28	96%	0	0%	0	0%
Abnormal	29	100%	1	4%	29	100%	29	100%
Total	29	100%	29	100%	29	100%	29	100%
Mean	**1,00**		**1,97**		**1,00**		**1,00**	
Std.deviation	**0,000**		**0,186**		**0,000**		**0,000**	
Uji Wilcoxon	**p = 0,000**				**p = 0,564**			
Uji Mann Whiteny	**p = 0,000**							

Based on table 2, it shows that before the ACBT (Active Cycle Of Breathing Technique) intervention was given, all respondents in the treatment group had abnormal lung function, namely 30 people (100.0). After the intervention was carried out, the lung function of most respondents became normal, namely 29 people (96.6). Before and after the intervention stage in the control group, all respondents had abnormal lung function, namely 30 people (100.0). The mean in the pre-test data of the treatment group was 1.00 and the post-test was 1.97, while the mean in the pre-test data of the control group was 1.00 and the post-test was 1.00. The results of the Wilcoxon signed rank test showed a ρ value in the treatment group of 0.000 (α <0.05), meaning that there was an effect of administering Active Cycle Of Breathing Technique (ACBT) on the lung function of pulmonary TB.

Discussion

In the treatment group before the Active Cycle of Breathing Technique (ACBT) intervention, all 30 respondents had abnormal lung function. After the intervention, the lung function of most respondents returned to normal (29 respondents). According to (8), administering ACBT three times daily for 15–20 minutes resulted in significant improvements in patients' respiratory status. This suggests that more intensive intervention frequency in patients requiring pulmonary rehabilitation can accelerate lung function recovery compared to less frequent interventions. This 15–20 minute session duration has been shown to be effective in improving the respiratory status of tuberculosis patients, as indicated by increased

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oxygen saturation and a significant reduction in respiratory rate. The decline in lung function in the respondents in this study was influenced by multifactorial risk factors. Previous studies have shown that individual characteristics such as age, gender, education level, and employment status are associated with a person's level of susceptibility to lung function decline (9).

The results of the study showed that most respondents in the treatment group were in the 18-59 age group, with a total of 25 people. According to research result, in this age group, decreased lung function is often related to delayed treatment, duration of exposure, and high workload, which makes individuals remain active despite experiencing respiratory symptoms. Mycobacterium tuberculosis infection causes chronic inflammation that can damage lung tissue (parenchyma), form cavities (holes), and trigger fibrosis (scarring) (10). Untreated or recurrent TB can lead to chronic conditions such as bronchiectasis and airway obstruction, which permanently reduce lung function (11).

The majority of respondents in the treatment group had a high school education (18 people). Education level influences the absorption of health information. The results of the study showed that most respondents in the treatment group were men (21 people) (12). Which is in line with epidemiological data in Indonesia stated that men are more susceptible to pulmonary tuberculosis than women (1). The results showed that the occupation of respondents in the treatment group was mostly laborers (9 people) the population of physical workers who have higher exposure to environmental risks (13).

Demonstrated that the ACBT technique, consisting of Breathing Control, Thoracic Expansion Exercise, and Forced Expiration Technique, effectively mobilizes secretions trapped in the airways. The increase in PEF and improvement in respiratory rate (RR) toward normal occurred due to reduced airway obstruction and increased thoracic expansion. Pathophysiologically, pulmonary TB patients experience chronic inflammation that triggers excess mucus production, which then causes mechanical obstruction in the airways. This accumulation of secretions increases airway resistance and forces the body to compensate by increasing the respiratory rate (RR) to maintain minute ventilation (14).

However, one respondent demonstrated abnormal lung function despite receiving intervention. This was due to the clinical condition at the time of measurement, which was during the intensive phase of treatment (1-2 months), where excessive secretion accumulation was still found, hindering optimal lung function recovery. This condition confirms that the response to ACBT can be influenced by the treatment phase and secretion load. All respondents in the control group, before and after the intervention phase, had abnormal lung function, including 29. In the control group, which only received standard therapy from the Manyar Community Health Center, this condition reflects the lack of significant changes in lung function in the control group before and after, due to the absence of specific interventions. The decline in lung function in the respondents in this study was influenced by multifactorial risk factors. Previous studies have shown that individual characteristics such as age, gender, education level, and employment status are associated with a person's level of susceptibility to decreased lung function (9) (15).

Based on the explanation above, the researchers concluded that in the control group, which did not receive Active Cycle of Breathing Technique (ACBT) intervention and continued to receive standard therapy from the Manyar Community Health Center, there were no significant changes in lung function. This suggests that pharmacological therapy alone without additional interventions for respiratory rehabilitation is insufficient to optimize lung function improvement in tuberculosis patients. In this case, the role of non-pharmacological interventions such as ACBT is very important, because structured breathing exercises that are carried out regularly can help increase lung capacity, improve breathing patterns, and support the healing process more optimally.

The study results indicate an effect of Active Cycle of Breathing Technique (ACBT) on pulmonary function in patients with pulmonary tuberculosis. In this study, Active Cycle of Breathing Technique (ACBT) was administered for 5 minutes, 3 times a day, for 4 days. Therefore, the duration and frequency of Active Cycle of Breathing Technique (ACBT) were chosen considering the condition of tuberculosis patients who were still in intensive or continuing treatment, ensuring that respiratory interventions were not too strenuous but frequent enough to stimulate pulmonary ventilation during the treatment period. In several respiratory physiotherapy studies, 10–20 minutes of exercise performed 1–3 times a day was deemed sufficient to improve airway clearance and breathing patterns without causing excessive fatigue. Therefore, 5 minutes per session, 3 times a day, can be considered a safe and tolerable intensity variation for TB patients (16). Breathing control exercises with slow, relaxed diaphragmatic breathing can reduce respiratory muscle work, reduce anxiety and respiratory rate, and stabilize ventilation patterns, thus

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reducing the risk of bronchospasm and making the lungs more ready for subsequent training. Once the breathing pattern is controlled (17)(18) , thoracic expansion exercises performed with deep, slow inspiration accompanied by short breath holds can increase lung volume, open collapsed alveoli, improve ventilation distribution, especially in the basal area, and help shift secretions to larger airways, thus impacting vital capacity and gas exchange efficiency (19). The final stage is forced expiration technique/huffing (FET) exercises, these exercises can mobilize and remove secretions from the periphery to larger airways without causing small airway collapse as in conventional coughing. Secretion clearance with the (FET) technique is more effective in reducing airway resistance and improving airflow, which is reflected in improvements in lung function parameters (20). The limitations of this study are that the intervention on days 2-4 was carried out door to door so it took a relatively longer time, this study did not measure the status of intensive phase treatment (1-2 months) and the volume of respondents' secretion production, which factors can affect the results of lung function measurements, and this study was only conducted at one location so that the results obtained cannot be generalized widely to other populations with different characteristics.

Conclusions and Recommendations

Before the intervention, all respondents in the treatment group had abnormal lung function. After the Active Cycle of Breathing Technique (ACBT) was implemented, most respondents in this group showed improvement, returning to the normal range. Conversely, in the control group, lung function remained abnormal both before and after the intervention. These findings demonstrate the effect of ACBT on lung function in tuberculosis patients.

Ethical Consideration and Competing Interest

This study has undergone ethical testing and received an ethical certificate from the KEPK of Noor Huda Mustofa University with number 3054/KEPK/UNIV-NHM/EC/III/2026. There is no conflict of interest in the research or writing of this article

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