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The Effect of *Deep Breathing Exercise* on *Tidal Volume* in *Pulmonary Tuberculosis* Patients at the Main Clinic of Purwokerto Community Lung Health Class A

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ABSTRACT

People with pulmonary tuberculosis often experience ventilation disorders due to lung tissue damage, leading to decreased elasticity and increased airway resistance. This condition reduces tidal volume and disrupts gas exchange and oxygenation. One nonpharmacological intervention that can help improve tidal volume is deep breathing exercise, which enhances lung ventilation and oxygenation. This study aimed to analyze the effect of deep breathing exercise on tidal volume in pulmonary tuberculosis patients at the Main Clinic of Purwokerto Community Lung Health Class A. A quasi-experimental design with one group pre-test and post-test was used, involving 28 patients in the intensive phase selected through total sampling. The intervention was conducted for three days. Tidal volume was measured via interactive video calls at the patients' homes using balloons and calculated with the formula $V = \pi r^2 t$. Each session was measured three times, and the highest value was recorded. The mean tidal volume increased from 2834.32 ml before intervention to 5365.00 ml after. Wilcoxon test results showed a p-value of 0.001, indicating a significant difference. In conclusion, deep breathing exercise is effective in increasing tidal volume in pulmonary tuberculosis patients and can be considered a supportive therapy.

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1. INTRODUCTION

Pulmonary tuberculosis, an infectious disease caused by *Mycobacterium tuberculosis*, is still a global health problem. Data WHO (2023), recorded a 6% increase in cases to 10.6 million cases worldwide, with Indonesia being one of the countries with a high burden. In Indonesia, *pulmonary tuberculosis* cases reach 0.38% of the population with a mortality rate of 134,000 cases per year (Profil Kesehatan Indonesia, 2023). At the regional level, Central Java Province experienced an increase in cases by 11.3%, while in Banyumas Regency the prevalence of *pulmonary tuberculosis* increased by 27.2% (Dinas Kesehatan Jateng, 2023). A similar increase was recorded at the Purwokerto Community Lung Health Main Clinic Class A, with a surge in cases of 26.3% from 2022 to 2023 *(Laporan KUKPMP, 2024).*

Pulmonary tuberculosis causes impaired respiratory function which is at risk of lowering *tidal volume*, impacting the gas exchange process, oxygen saturation, and the patient's quality of life (Kemenkes RI, 2024; Rosaulina et al., 2023). *Tidal volume* optimization is important in supporting healing and preventing further

complications. Various non pharmacological efforts have been used to improve respiratory function, one of which is *deep breathing exercise* which has been proven to increase lung capacity and oxygen saturation (Sodikin et al., 2022; Pajarrini et al., 2022). Some studies have shown that DBE is up to 75–80% effective in helping improve respiratory function compared to other methods such as the semi-fowler position or effective cough technique (Barangkau, 2023; Rahmawati & Ainun, 2024).

The optimization of the promotive and preventive role in the primary service system is still not running optimally, so more focused educational efforts are needed to meet the clinical needs of *pulmonary tuberculosis* patients, especially in increasing the capacity and effectiveness of respiratory function. One of the important indicators in improving respiratory function is an increase in *tidal volume*, which is the amount of air entering and exiting the lungs in a normal breathing cycle, which often decreases due to lung tissue damage in *pulmonary tuberculosis* patients. One of the effective steps to overcome this condition is to teach *deep breathing exercises* regularly to patients and families as part of independent education, in order to increase *tidal volume* and support the improvement of patients quality of life.

Based on this, this study aims to determine the effect of *deep breathing exercise* on *tidal volume* in *pulmonary tuberculosis* patients at the Purwokerto Class A Community Lung Health Main Clinic.

2. RESEARCH METHOD

This type of research is *a quasi-experiment* with *a one-group pre-test post-test design* involving 28 patients with intensive phase pulmonary tuberculosis at the Purwokerto Community Lung Health Main Clinic Class A with a total sampling technique. The independent variable is *deep breathing exercise*, while the dependent variable is tidal volume. The *deep breathing exercise* intervention was carried out for three consecutive days. The selection of a three-day duration was based on evidence that short-term but repetitive breathing exercises are able to induce physiological adaptations in the respiratory muscles thereby increasing lung expansion (Rinarto et al., 2021; Rahmawati & Rosidah, 2023). In addition, research Maulida (2024), It shows that the application of *deep breathing exercise* twice a day with a duration of 5–10 minutes every session for three days has been shown to help increase oxygen saturation in patients with respiratory diseases. Thus, the duration of three days is considered adequate to cause early changes in lung function as well as practical in improving the compliance of intensive phase pulmonary tuberculosis patients.

Data collection was carried out twice, namely pre-test on the first day at the clinic before the intervention and post test on the third day after the intervention through an interactive video call so that the researcher could monitor the *deep breathing exercise* technique directly at the patient's home. This method was chosen to minimize discomfort if the respondents continue to be accompanied by nurses directly and reduce the risk of transmission. Respondents were asked to do *deep breathing exercises* according to the procedures that had previously been taught at the clinic and supported by the DBE KIT which contained educational leaflets (training schedules, benefits, and *deep breathing exercise* guides), balloons, daily observation sheets, measuring tapes, and stationery. During the video call session, the researcher ensured that the respondents performed the *deep breathing exercise* correctly, while the family was involved to help supervise compliance and accuracy of the implementation when participating in the video call.

Tidal volume measurement using balloon instruments is a simple alternative to spirometers because it is more practical, cheap, easy to obtain, and safe to use at home for pulmonary tuberculosis patients without having to use advanced medical equipment. Respondents were asked to inspire and then blow balloons in one breath. The patient's family who had been given simple training measured the diameter and length of the balloon using a tape measure with the researcher's direction via video call. Furthermore, the volume of the balloon was calculated using the tube formula $(V=\pi r^2 t)$, so that an estimate of the patient's tidal volume was obtained. This method has been validated as a tool for estimating lung volume under limited conditions (Musakkir, 2023; Octasari dan Yulistiani, 2024). The estimated tidal volume obtained was then analyzed using *the Shapiro-Wilk* normality test. Because the results showed that the data were not normally distributed, the *Wilcoxon test* was used to analyze the effects of the intervention.

3. RESULT AND DISCUSSION

Based on the results of the research, the following results were obtained:

3.1 Respondent Characteristics

Table 1. Characteristics of respondents (n=28)

Characteristics	***Frequency***	***Percentage (%)***
Gender		
a. Male	14	50,0 %
b. Female	14	50,0 %

Characteristics	*Frequency*	*Percentage (%)*
Age		
a. 19 – 29 *Years*	6	21,4 %
b. 30 – 39 *Years*	8	28,6 %
c. 40 – 49 *Years*	9	32,1 %
d. 50 – 59 *Years*	5	17,9 %
Education		
a. Elementary School	11	39,3 %
b. Junior High School	9	32,1 %
c. Senior High School	7	25,0 %
d. Collage	1	3,6 %
Occupation		
a. Trader	13	46,4 %
b. Laborer	11	39,3 %
c. Housewife	4	14,3 %
Ideal Body Weight		
a. Ideal	9	32,1 %
b. Underweight	19	67,9 %
Total	28	100

Based on table 1, as many as 28 respondents have received interventions in this study. The proportion of genders was balanced, 14 males (50.0%) and 14 females (50.0%) respectively. The majority of respondents were in the age range of 40–49 years (32.1%), with other age distributions being 19–29 years (21.4%), 30–39 years (28.6%), and 50–59 years (17.9%). In terms of education, most of the respondents were educated at the end of elementary school (39.3%), followed by junior high school (32.1%), high school (25.0%), and college (3.6%). Based on occupation, the majority of respondents were traders (46.4%), followed by workers (39.3%), and housewives (14.3%). Meanwhile, based on the ideal weight category, most of the respondents were classified as thin (67.9%) and the rest had an ideal weight (32.1%).

3.2 Tidal Volume Before and After *Deep Breathing Exercise*

Table 2. Frequency Distribution of *Tidal Volume* of *Pulmonary Tuberculosis* Respondents Before and After *Deep Breathing Exercise*

	Mean	*SD*	*Min*	*Max*
Pre Test	2834,32	1948,287	381	6466
Post Test	5365,00	2579,955	1244	9948

Based on table 2, the frequency distribution of the respondents' *tidal volume* showed an average increase from 2834.32 ml to 5365.00 ml after being given *Deep Breathing Exercise* (DBE). Before exercise, the mean value of 2834.32 ml reflected ventilation disorders due to airway obstruction, secretion accumulation, and pleuritic pain that caused shallow breathing (Faizatul, 2024). *Pulmonary tuberculosis infection* can also damage lung tissue and decrease elasticity, thus inhibiting air exchange (Rahmawati & Rosidah, 2023). After DBE was done for three days, the *tidal volume* increased to an average of 5365.00 ml. This increase occurs because DBE helps strengthen the respiratory muscles through motor adaptation, especially the diaphragm opening the airways (Rumilang & Sari, 2024). And increased ventilation efficiency, so that lung capacity and *tidal volume* of *pulmonary tuberculosis* patients increase (Mar'iyah & Zulkarnain, 2021).

3.3 Differences in *Tidal Volume* Before and After *Deep Breathing Exercise*

Table 3. Differences in *Tidal Volume* Before and After *Deep Breathing Exercise* in *Pulmonary Tuberculosis* Respondents

Deep Breathing Exercise	*N*	*Volume Tidal*			*Z Value*	*p-value*
		Mean	*Min*	*Max*		
Pre Test	28	2834,32	381	6466	-4,623	0,001

Deep Breathing Exercise	*N*	*Volume Tidal*			*Z Value*	*p-value*
		Mean	*Min*	*Max*		
Post Test	28	5365,00	1244	9948		

Based on table 3, it was shown that for three days the administration of *deep breathing exercise* had a significant effect on increasing tidal volume in pulmonary tuberculosis patients ($p = 0.001$; $p < 0.05$). An increase in tidal volume indicates an improvement in lung capacity and ventilation efficiency, which is achieved through optimization of the work of the respiratory muscles.

The increase in tidal volume reflects improved lung capacity and ventilation efficiency, which is achieved through optimization of the work of the respiratory muscles, including the diaphragm and external intercostal muscles. In patients with pulmonary tuberculosis, chronic inflammatory processes and the formation of scar tissue decrease lung elasticity and increase airway resistance, so that without exercise, the lungs' ability to hold air is reduced and the tidal volume decreases.

These findings are in line with research Zuriati et al., (2021), who reported that breathing exercises can improve lung function in tuberculosis patients. The connection with this study is that the improvement in lung function is directly reflected in the increase in tidal volume, since more elastic lungs and stronger respiratory muscles allow more air to enter at each breathing cycle. Supported by research Manurung et al., (2022), that *deep breathing exercise* using *the balloon blowing technique* can increase oxygen saturation and increase the vital capacity of the lungs. This correlation confirms that the increase in vital capacity has direct implications for an increase in tidal volume as a parameter of lung function.

Moreover Novitasari & Aminah (2020), It is reported that *deep breathing exercise* can improve breathing patterns and increase oxygen saturation in tuberculosis patients. The results of this study support these findings, because the increase in tidal volume increases alveolar ventilation and oxygen pressure gradients, so that gas exchange becomes more effective and oxygen saturation improves. In accordance with research Pajarrini et al. (2022), that simple breathing exercises can accelerate the recovery of lung function in patients with chronic infectious lung disease, which is consistent with the findings of this study that tidal volume improvement is an indicator of improved lung function.

Thus, the results of this study strengthen the evidence that *deep breathing exercise* is an effective non-pharmacological intervention to increase tidal volume and lung capacity, improve breathing patterns, and increase oxygen saturation in pulmonary tuberculosis patients. The consistency of the findings with previous research confirms that this *deep breathing exercise* is worthy of being recommended as part of the pulmonary rehabilitation program for pulmonary tuberculosis patients.

4. CONCLUSION AND RECOMMENDATION

Based on the study, it was concluded that *Deep Breathing Exercise* carried out for three days was proven to have a significant effect in increasing tidal volume in pulmonary tuberculosis patients, with an average increase from 2834.32 mL to 5365.00 mL ($p = 0.001$). *Deep breathing exercise* is a simple, safe, and independent intervention at home with family support and monitoring by health workers via video call. Therefore, *deep breathing exercises* are recommended to be integrated into pulmonary rehabilitation programs in pulmonary tuberculosis patients. Meanwhile, follow-up studies with longer intervention durations, comparison groups, and spirometry-based measurements are needed to strengthen the evidence of its effectiveness.

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