

Original Article

A Pre-Experimental Study on the Effect of Proning Position on Oxygen Saturation in Pulmonary Tuberculosis Patients



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ABSTRACT

Background: Pulmonary tuberculosis (TB) is an infectious disease that primarily affects the lung parenchyma. Common moderate symptoms include dyspnea and hypoxemia. Prompt and effective management of hypoxia is crucial to prevent further organ damage. One non-invasive and easily administered intervention is the use of the proning position, which facilitates improved oxygen intake. This study aims to examine the effect of the proning position on increasing oxygen saturation in patients with pulmonary tuberculosis.

Methods: This pre-experimental study used a one-group pretest–posttest design. The study involved 35 patients with pulmonary TB treated in the Wijaya Kusuma 3 Ward of Kartini Karanganyar Regional Public Hospital during December 2023. Inclusion criteria were: drug-sensitive pulmonary TB, oxygen saturation <94%, fully conscious, no severe respiratory distress, and willingness to participate. Exclusion criteria included unstable hemodynamics, spinal injuries, or contraindications to positional changes. Each patient underwent a series of five proning positions (prone, right and left lateral, and right and left semi-sitting side-lying), with each position held for 30 minutes. Oxygen saturation levels were measured before and after the intervention. Data were analyzed using a paired t-test.

Results: The mean oxygen saturation increased from 93.87% before the intervention to 96.97% after the proning technique. Post-intervention saturation ranged between 96% and 99%. Statistical analysis showed a significant improvement in oxygen saturation following the intervention ($p < 0.001$)

Conclusion: The proning position significantly improves oxygen saturation in patients with pulmonary tuberculosis. It is recommended as a supportive, non-invasive intervention for managing hypoxemia in pulmonary TB cases.

Keywords: Oxygen saturation; proning position; pulmonary tuberculosis.

Implications for Practice:

- The proning position can be used as a routine intervention to increase oxygen saturation in pulmonary TB patients.
- This practice is effective, inexpensive, and easy to apply by healthcare workers in the treatment room.
- The proning position can reduce the risk of invasive interventions such as the use of a breathing apparatus.
- Training and socialization of nurses and medical personnel need to be carried out to optimize the implementation of the proning position.

Introduction

Pulmonary Tuberculosis (Pulmonary TB) is an infectious disease caused by

Mycobacterium tuberculosis that primarily affects the lung parenchyma (Darmin et al., 2020). Common clinical manifestations

include a persistent cough (with or without sputum), fever, night sweats, weight loss, and shortness of breath. One significant complication in pulmonary TB is dyspnea, which arises due to inflammation and damage to extensive areas of lung tissue, leading to impaired gas exchange. If left untreated, this can progress from hypoxemia to life-threatening hypoxia ([Dian Novita Hanggi, 2020](#)).

According to the World Health Organization (WHO), pulmonary tuberculosis ranked as the second leading cause of death globally in 2020, following COVID-19, with 1.5 million deaths and approximately 10 million new cases, affecting 5.6 million men, 3.3 million women, and 1.1 million children ([Amalia et al., 2022](#)). In Indonesia, tuberculosis remains a major public health concern, with 845,000 cases and an estimated 98,000 deaths annually, or 11 deaths per hour ([Kleden et al., 2024](#)). In Karanganyar Regency, 36.2% of the population had pulmonary TB cases, with a treatment success rate of 94.5% ([Nuraeni et al., 2023](#)).

Pharmacological treatment for pulmonary TB consists of two stages: an intensive phase (2–3 months) and a continuation phase (4–7 months), using first-line drugs such as isoniazid, rifampicin, pyrazinamide, and ethambutol, and second-line drugs when resistance is present ([Longe & Bindukinasih, 2022](#)) ([Putri et al., 2024](#)). However, in patients with respiratory complications such as dyspnea and oxygen desaturation, additional supportive therapy is needed to maintain adequate oxygenation.

Oxygen saturation, the percentage of oxygen bound to hemoglobin in the blood, is a critical parameter for monitoring respiratory function. Normal saturation ranges from 95% to 100%. Values below 94% indicate hypoxemia and, if unmanaged, may lead to hypoxia ([Dekayana, 2021](#)). In such cases, oxygen therapy is essential. While conventional oxygen delivery

systems are helpful, there is growing interest in alternative, non-invasive methods to enhance oxygenation.

One such method is the proning position, which involves placing the patient in a prone or forward-leaning position. Derived from the Latin word *pronus*, meaning “bent forward,” this technique has been widely adopted for COVID-19 patients with hypoxemia. It has been shown to improve lung recruitment, ventilation-perfusion matching, and secretion clearance. Studies have demonstrated that the prone position improves oxygen saturation and reduces the need for invasive ventilation in COVID-19 patients ([Anand et al., 2021](#); [Bamford et al., 2020](#); [Chad & Sampson, 2020](#)).

Despite extensive research on proning in COVID-19, limited studies have examined its application in patients with pulmonary tuberculosis. Given that TB also involves lung inflammation, impaired alveolar ventilation, and reduced oxygenation, the physiological rationale for proning may extend beyond viral pneumonia to bacterial infections such as TB. A study by [Wiraputri et al. \(2023\)](#) found that the prone position improved oxygen saturation in TB patients, suggesting that this method may enhance alveolar recruitment and gas exchange even in non-COVID-19 pulmonary pathology. Furthermore, the Indonesian Lung Doctors Association has recognized the potential of the prone position to maintain alveolar openness and optimize oxygenation.

A preliminary study conducted on December 1, 2023, involving 15 TB patients with oxygen saturation levels of 92%–94%, revealed that after performing the proning technique, 73.3% of participants experienced an increase in oxygen saturation to 95%–97%. This finding suggests a potential benefit of implementing proning as an adjunctive therapy in TB management.

This study seeks to address a significant research gap by investigating the effect of

the proning position on oxygen saturation in patients with pulmonary tuberculosis, a population for whom this intervention has not been widely explored. While evidence of proning's benefits exists in COVID-19, its use in bacterial lung infections like TB remains under-researched, making this study both timely and potentially impactful.

The objective of this study is to evaluate the effect of the proning position on oxygen saturation in pulmonary tuberculosis (TB) patients treated in the Wijaya Kusuma 3 Ward of Kartini Karanganyar Regional Public Hospital. Specifically, the study aims to measure the increase in oxygen saturation levels in drug-sensitive pulmonary TB patients following the application of the proning position and to examine the relationship between the proning position and improvements in oxygen saturation. The study hypothesizes that the proning position significantly increases oxygen saturation in pulmonary TB patients at the Wijaya Kusuma 3 Room of Kartini Karanganyar Regional Public Hospital.

Methods

Study Design

This study employed a pre-experimental one-group pretest-posttest design, where oxygen saturation levels in pulmonary tuberculosis (TB) patients were measured before and after the proning intervention. This design allowed the researcher to assess changes in oxygen saturation attributable to the proning position within the same group of participants.

Participants

The population consisted of 35 patients with drug-sensitive pulmonary tuberculosis treated in the Wijaya Kusuma 3 Ward of Kartini Karanganyar Regional Public Hospital during December 2023. Total sampling was used, and participants

were included if they met the following criteria: (1) diagnosed with drug-sensitive pulmonary TB, (2) oxygen saturation <94%, (3) no signs of severe respiratory distress, (4) fully conscious, and (5) willing to participate. Patients with unstable vital signs or comorbidities requiring intensive care were excluded. While total sampling was used, no prior power analysis was conducted to determine the minimum required sample size.

Instruments

The independent variable was the application of the proning position. The dependent variable was oxygen saturation level. A standard pulse oximeter was used to measure oxygen saturation (SpO₂) levels, while an observation sheet was employed to record the application of the proning technique. Although clinical guidelines structured the observation sheet, no validation metrics (e.g., Cronbach's alpha) were reported.

Intervention

The independent variable is the implementation of the proning position, which refers to placing the patient in a prone position (lying face-down) over the abdomen. The procedure involves five different body position changes, each maintained for 30 minutes. These are systematically recorded using an observation sheet with a nominal data scale. Scoring is based on the number of proning positions performed, ranging from position 1 through position 5. The proning technique followed a structured Airway-Positioning Support (SAP) protocol consisting of five sequential body positions aimed at optimizing oxygenation. Each participant underwent the following positions: (1) prone (lying on the stomach), (2) right tilt, (3) left tilt, (4) right half-sitting, and (5) left half-sitting. The total duration of the intervention was 2.5 hours per patient. The procedure was performed under the

supervision of trained nurses. No blinding was implemented due to the nature of the intervention.

The dependent variable is oxygen saturation, defined as the percentage of oxygen carried by hemoglobin in the blood. This is measured using a pulse oximeter clipped to the patient's finger, which assesses the saturation level based on the light reflected by the capillaries. The oxygen saturation is categorized on an ordinal scale, with scores classified as follows: 95–100% (normal), >94% (normal range), 90–94% (mild hypoxemia), 75–79% (moderate hypoxemia), and <75% (severe hypoxemia) (**Table 1**).

The standard procedure for the proning position begins with understanding its purpose: to improve oxygenation and respiratory function, increase lung volume, reduce atelectasis, and enhance secretion drainage. It is indicated for patients with hypoxia who require more than 2 liters of oxygen per minute to maintain saturation

above 94%, provided they do not show signs of severe respiratory distress, are fully conscious, and can perform the position independently. Contraindications include head or neck trauma, spinal instability, history of sternotomy, hemoptysis, hemodynamic instability, pregnancy, and heart disorders. Equipment required consists of a bed, pillows, and rolled towels. Before the procedure, nurses are to verify patient data, perform hand hygiene, and prepare the equipment. Patients are educated about the benefits of the proning position and instructed to call for assistance if discomfort arises. The procedure includes hand hygiene, patient identification, communication, positioning, and support with pillows under the head, abdomen, and feet. After maintaining the position for 30 minutes, patient responses, both verbal and non-verbal, are evaluated. The session ends with positive reinforcement and scheduling of the next intervention.

Table 1. Patient Oxygen Saturation Observation Sheet

Pretest Oxygen Saturation (%)	Post Test Oxygen Saturation (%)					Sum
	1 (Stomach)	2 (left side)	3 (half seated)	4 (right side)	5 (Stomach)	

Data Collection

Oxygen saturation was measured and recorded before (pretest) and after (posttest) the proning intervention. Observations were conducted by trained personnel using a consistent protocol to minimize inter-observer bias.

Data Analysis

Data were analyzed using SPSS software version 23.0. Univariate analysis described the demographic characteristics of participants (gender, age, occupation, and education) using frequency distributions. Bivariate analysis employed the paired samples t-test to assess differences between

pre- and post-intervention oxygen saturation levels. A significance level of $p < 0.05$ was used. Assumptions of normality and equal variances were evaluated before applying the t-test.

Ethical Considerations

This research involved human participants (pregnant women), making ethical compliance essential. The key ethical issues that were discussed were getting informed consent, protecting participant privacy, keeping data private, and reducing any possible physical or mental suffering that might occur during data collection. Every respondent was made fully aware of

their freedom to leave at any time without facing any repercussions. The STIKes Mitra Husada Karanganyar Health Research Ethics Committee examined and approved the project. This study, which has the number 009/KEPK-STIKes MHK/EC/V/2024, satisfies the ethical feasibility standards.

Results

Descriptive data were used to describe the characteristics of respondents based on age, gender, occupation, and education.

Table 2. Characteristics of Research Respondents

Characteristic	Frequency	Percentage
Age		
< = 20 years	2	5.7%
21 - 30 years old	5	14.3%
31 - 40 years old	6	17.1%
41 - 50 years old	10	28.6%
> 50 years	12	34.3%
Gender		
Man	15	42.9%
Woman	20	57.1%
Work		
Farmer	2	5.7%
IRT	11	31.4%
Employee	1	2.9%
Factory employees	6	17.1%
Student	1	2.9%
Merchant	4	11.4%
Farmer	1	2.9%
Civil Servant	1	2.9%
Driver	1	2.9%
Self employed	7	20.0%
Education		
Bachelor	3	8.6%
Elementary School	4	11.4%
Senior High School	12	34.3%
Vocational High School	9	25.7%
Junior High School	6	17.1%
Industrial High School	1	2.9%

Based on descriptive data from the respondent characteristics **table 1**, it can be concluded that the majority of respondents are women (57.1%) compared to men (42.9%). Most respondents were over 50 years old (34.3%), followed by respondents aged 41-50 years (28.6%). Respondents' education was dominated by senior high school (34.3%) and vocational high school (25.7%) graduates, while for jobs, the majority were housewives (31.4%) and self-employed (20.0%). There was variation in the types of jobs respondents held, with a

small proportion of them working as farm labourers (5.7%), factory workers (17.1%), and traders (11.4%). This picture indicates the diversity in the demographic and socio-economic characteristics of the respondents in this study.

To determine the effect of the proning position on oxygen saturation levels in pulmonary tuberculosis (Pulmonary TB) patients, a comparison was made between the oxygen saturation values before and after the intervention. The following table presents the descriptive statistics for



oxygen saturation measured in 35 patients in the Wijaya Kusuma Room 3 of Kartini Karanganyar Hospital.

Table 3 and **Figure 1** show a substantial improvement in oxygen saturation following the proning intervention. Before the proning position was applied, the average oxygen saturation (pretest) was 91.20%, with a minimum value of 88.00% and a maximum of 94.00%. After the intervention (posttest), the mean oxygen saturation increased to 97.41%, with a narrower standard deviation (0.74) and values ranging from 95.69% to 98.80%. This suggests a consistent and significant rise in oxygen saturation levels in pulmonary TB patients following the proning position, indicating the potential effectiveness of this non-invasive technique in improving respiratory function.

Convergent validity is the evaluation of the values obtained from outer loadings. Outer loadings are considered high when

their correlation with the structure being measured exceeds 0.7, although a value of 0.6 has been deemed sufficient to meet the convergent validity requirement ([Ghozali & Latan, 2020](#)).

Based on the results of the normality test in the table above, it can be seen that the significance value or p-value in the pretest data is $0.134 > 0.05$, and in the posttest data is $0.836 > 0.05$, so that the data is distributed normally.

A parametric test utilizing a paired sample t-test was conducted to ascertain the impact of proning position on raising oxygen saturation in patients with pulmonary tuberculosis. The test's objective was to compare the same group's average oxygen saturation levels before and after the intervention. The following are the results of *the paired sample statistics test* for 35 respondents who have undergone proning positions in the Wijaya Kusuma 3 Room of Kartini Karanganyar Hospital:

Table 3. Oxygen Saturation, Normality Test, and Paired t-test Results in Pulmonary TB Patients After Proning Intervention

Measurement	Mean	Median	Std. Deviation	Min-Max	Statistic (Normality)	df	p-value	Mean Difference	t	p-value (2-tailed)
Pretest (SpO ₂ %)	91.2	91	1.41	88.00 – 94.00	0.952	35	0.134			
Posttest (SpO ₂ %)	97.41	97.4	0.74	95.69 – 98.80	0.982	35	0.836	6.21	-34.11	0.000

The results of the paired sample t-test indicate a statistically significant increase in oxygen saturation following the proning position intervention. The mean difference between posttest and pretest oxygen saturation was 6.21%, with a standard deviation of 1.08. The calculated t-value of -34.11 with 34 degrees of freedom resulted in a p-value of <0.001 ($p < 0.05$), which confirms that the improvement in oxygen saturation is statistically significant. Therefore, it can be concluded that the proning position has a meaningful and positive effect on oxygen saturation in pulmonary TB patients.

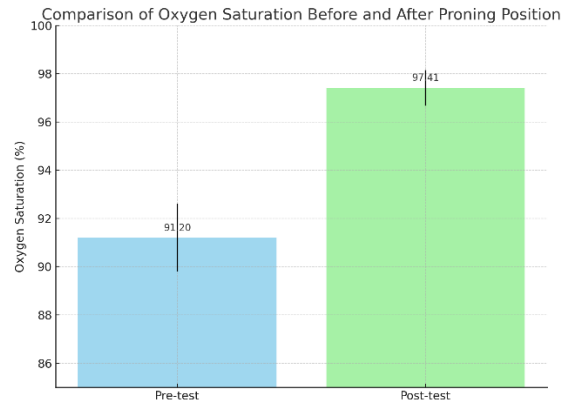


Figure 1. Comparison of Oxygen Saturation Before and After Proning Position

Discussion

Oxygen Saturation Before Prone Position Therapy

The results of the study showed that from 35 respondents in the Pulmonary Tuberculosis (Pulmonary TB) group before being given a prone position, the average pretest oxygen saturation value was 91.20%. The minimum oxygen saturation value of Pulmonary Tuberculosis (Pulmonary TB) patients before being given a prone position was 88% and the maximum saturation value was 94%.

The infectious condition known as pulmonary tuberculosis mostly affects the lung's parenchyma. One of the illnesses affecting the lower respiratory tract is pulmonary tuberculosis, an infectious disease brought on by the bacteria *Mycobacterium tuberculosis*. The majority of mycobacterium TB germs enter lung tissue via infecting the airborne, and they then progress through a process called primary foci. One of the symptoms of tuberculosis is a form of tightness. This symptom is found when the damage to the pulmonary parenchyma is extensive due to accompanying conditions such as pleural effusion, pneumothorax. It occurs when it is advanced, where inflammatory infiltration reaches half of the lungs. This is what makes tuberculosis patients experience a decrease in oxygen saturation ([Milwati et al., 2024](#)).

The appearance of oxygen-bound hemoglobin in the arteries is known as oxygen saturation; a normal oxygen saturation range is 95–100%. In medicine, oxygen saturation (SpO₂) is frequently referred to as "SATS" to indicate the proportion of oxygen in the blood that is bound by hemoglobin. Most hemoglobin is deoxygenated at low partial oxygen pressure, which means that oxygenated blood is not being distributed from the arteries to the body's tissues ([Apui et al., 2023](#); [Kitu et al., 2020](#)). Meanwhile, hemoglobin itself is a metalloprotein in red blood cells (erythrocytes) that functions as an oxygen carrier (O₂) from the lungs to the rest of the body. Hemoglobin, also a transporter of carbon dioxide (CO₂), returns to the lungs to be exhaled out of the body ([Mulyani et al., 2024](#)).

If the oxygen saturation drops below 94%, then the patient may have problems with his lungs, so he will be at risk of experiencing decreased lung function. This can cause several respiratory distresses. These respiratory disorders will also occur in patients who are suffering from tuberculosis bacteria, where these bacteria attack the respiratory tract. The bacteria will use the epithelial cells and mucosa of the airway as initial targets and cause infection in the airways or organ damage, causing the patient to become congested.

Shortness of breath is characterized by a decrease in oxygen levels in the body.

Oxygen levels are an important indicator in tuberculosis patients. Oxygen levels in the body can be found using the Oximeter device. Normally, oxygen levels or percent SpO₂ are in the range of 95% - 100%. Tuberculosis patients are usually characterized by fever, plus one of the symptoms is a respiratory rate >30x/minute, severe respiratory distress, or low oxygen saturation of 93%.

In this study, the oxygen levels of patients with Pulmonary Tuberculosis before the proning technique were low (oxygen saturation 88-94%). This is because the patient has been exposed to tuberculosis bacteria with a moderate/moderate degree category. The patient is already experiencing signs of clinical symptoms such as fever, cough, rapid breathing, accompanied by a decrease in oxygen saturation levels in the blood. Some patients are accompanied by pleural effusion.

Oxygen Saturation After Prone Position Therapy

The results showed that from 35 respondents in the Pulmonary Tuberculosis group after the proning position was performed, the results were obtained with the average oxygen saturation value of the posttest which was 97.41% and the minimum oxygen saturation value of Pulmonary Tuberculosis (Pulmonary TB) patients after the proning position was carried out the saturation proning position which was 95.69% and the maximum saturation value was 98.80%. Health workers face considerable challenges in today's health world. Various interventions are developed and implemented in patients with Pulmonary Tuberculosis (Pulmonary TB) to improve patient independence and treatment success.

One of the newly studied interventions is the proning position in drug-sensitive Pulmonary Tuberculosis (Pulmonary TB) patients who are not accompanied by

weight loss. The prone position is a prone sleeping position for patients who have respiratory problems. Positioning the patient in a prone environment leads to alveolus configuration and perfusion, thereby reducing ventilation/perfusion mismatches ([Amalia et al., 2022](#)). The prone position improves the fit of the lung's form with the chest cavity and decreases the pleural pressure gradient between the dependent and non-dependent lung regions of gravity. This increases the recruitment of dorsal lung units by promoting more uniform lung aeration and pressure distribution. The proning position can also increase the clearance of secretions. The dorsal-to-ventral orientation of the main airway results in more efficient drainage of secretions ([Koeckerling et al., 2020](#)).

The main purpose of the proning position action is to increase oxygenation. Decreased oxygen saturation in patients with Pulmonary Tuberculosis (Pulmonary TB) can have a bad impact if not treated immediately. In addition to other vital signs like blood pressure, temperature, and blood sugar, oxygen saturation must be monitored. A blood oxygen level that is excessively low, or hypoxia, might exacerbate pre-existing conditions. Proning at the right time and maintaining proper airflow can save many lives. This effort is an alternative so that patients with mild to moderate symptoms do not worsen.

Effect of Proning Position on Oxygen Saturation

The Effect of Proning Position on Increasing Oxygen Saturation in Pulmonary Tuberculosis (Pulmonary TB) Patients at Kartini Hospital, Karanganyar Regency Based on Table 7, it shows that the results of the premetric test using the statistical analysis technique of correlated data paired samples t-test obtained a significant value of <0.001 from these results, it can be interpreted that there is an effect of prone position therapy on the increase in oxygen

saturation because the significant value is less than 0.05. Prone's position is well-known amid the covid-19 pandemic where several hospitals and health services in Indonesia have experienced a shortage of oxygen due to the use of oxygen therapy for covid-19 patients which due to the number of confirmed cases is increasing and the number of inpatients exceeds the capacity of the hospital room with a Bed Occupancy Rate (BOR) value or the percentage of bed use in a certain period which is an average of 90%, The ideal BOR should be 60-80 ([Heltiani et al., 2022](#)).

The prone position, as the best effort to reduce shortness of breath, is considered very important. When lying down or sitting, the heaviest position of the lungs rests on the back, making it difficult to get enough air, in contrast to the prone position, where the head is lower than the shoulders, making the lung load more evenly so that it can increase the flow of oxygen. The prone position can improve gas exchange through a decrease in transpulmonary pressure (the difference between airway opening pressure and pleural pressure). The prone position causes the weight of the intrathoracic viscera and abdomen to be removed from the lungs and the limited movement of the diaphragm to be relieved. Because the dorsal region of the lungs, which is rich in gravity-dependent blood flow, is in an independent posture, the prone position also improves breathing by increasing the aeration of the poorly ventilated alveolar section ([Jagan et al., 2020](#)).

The findings of this study are consistent with those of [Wiraputri et al. \(2023\)](#). With the lowest oxygen saturation value being 96% and the maximum being 99%, the analysis of oxygen saturation data following the prone approach yielded an average value of 96.97%. According to the interval estimation results, 95% of patients are thought to have an average oxygen saturation following prone that falls

between 96.65 and 97.28%. This occurs due to an increase in the patient's oxygenation status and the presence of pressure on the pleura that is not homogeneous, alveolar inflation and ventilation, then an increase in lung volume so that there will be a decrease in the area of atelectasis and increase airway clearance, so that much blood will flow to the anterior region in the dependent area. So that there is an increase in oxygenation in the lungs.

This prone position can increase the oxygen saturation of patients, especially patients with tuberculosis (TB). The findings of this investigation are corroborated by studies on newborns' mobilization of posture changes, as suggested by [Lukmanulhakim & Musfirowati \(2024\)](#). In his research, the results showed that by being given mobilization (prone, lateral, head on bed) to 31 critical patients, it showed significant results in increasing oxygen saturation/SPO₂, Respiratory Rate/RR, and Heart Rate/HR. The SPO₂ value reached 99% after mobilization and 98% before mobilization. This is also in line with research conducted by [Ulpah & Musthofa \(2022\)](#), which obtained from the SpO₂ measurement results before the prone position intervention averaged 94.65% and after the prone position intervention, 96.17%. There was a difference in SpO₂ before and after the prone position intervention, with an average increase in SpO₂ of 1.52% (1.61%)

According to research [López-Taboada et al. \(2020\)](#), the prone position can increase oxygenation, with the average SpO₂ achievement rising from 94% to 98%. In addition, in the study, it was also found that there was an increase in PaO₂/FIO₂ from 89 to 165 mmHg; this condition is also supported by research conducted by [Jouffroy et al. \(2021\)](#). The same thing was expressed by [Solverson et al. \(2021\)](#) that the prone position increases SpO₂ from 91% to 98%.

From the review of the results of current research and previous research, supported by Theory, the researcher can conclude that there is an effect of proning position on increasing oxygen saturation in patients with Pulmonary Tuberculosis (Pulmonary TB). The proning position has a role in preventing patients from Pulmonary Tuberculosis (Pulmonary TB) from falling into a condition of respiratory failure because it can improve lung ventilation. This effort is an alternative so that patients with pulmonary tuberculosis (Pulmonary TB) with mild to moderate symptoms do not worsen. The use of the proning position in moderate respiratory disorders experienced by patients with Pulmonary Tuberculosis (Pulmonary TB) is quite safe to do. It is recommended that nurses implement proning positions in patients with respiratory distress, but with strict supervision.

Nonetheless, limitations must be acknowledged. This study lacked a control group, which restricts the ability to attribute improvements solely to the proning intervention definitively. Additionally, measurement bias may have influenced results due to reliance on pulse oximetry without arterial blood gas confirmation. The sample was drawn from a single hospital ward, which may limit generalizability.

Relevance to Clinical Practice

The findings of this study carry important implications for clinical practice, particularly in the non-invasive management of pulmonary tuberculosis (pulmonary TB) patients experiencing oxygenation impairment. The proning position has been statistically shown to significantly improve oxygen saturation levels, supporting its integration as a supportive respiratory intervention in hospital settings. This technique can be implemented easily, requires minimal equipment, and can be carried out by

trained nursing staff under appropriate supervision.

However, the generalizability of these findings should be approached with caution. The study was conducted in a single hospital ward. It may not fully reflect outcomes across different healthcare settings with varying resources or among patients with more severe TB complications, such as extensive cavitary disease or comorbidities. Future research is needed to evaluate the effectiveness of proning positions across broader clinical contexts.

To ensure effective implementation, hospitals—especially in Indonesia—could integrate proning protocols into routine nursing care for TB patients with mild to moderate hypoxemia. This may involve standardized steps, including assessment of contraindications, monitoring of vital signs during the procedure, scheduling proning intervals (e.g., 2–4 hours per session), and patient education to ensure comfort and safety.

The Indonesian Ministry of Health's *Pedoman Nasional Penanggulangan Tuberculosis* (2020) does not yet include the proning position as part of its standard treatment guidelines for TB. However, given the growing evidence supporting its utility in improving oxygenation, health authorities and hospital-based TB programs may consider updating protocols to incorporate this practice as a low-cost, non-invasive adjunct to oxygen therapy.

Conclusion

This study demonstrates that the implementation of the proning position significantly improves oxygen saturation levels in patients with pulmonary tuberculosis. The intervention offers a non-invasive, cost-effective strategy to enhance respiratory function in patients experiencing mild to moderate hypoxemia. These findings support the clinical application of proning as a supportive

measure in the respiratory management of pulmonary TB cases, particularly in settings where access to advanced respiratory support is limited.

Based on the findings of this study, it is recommended that the proning position be implemented as a supportive intervention to improve oxygen saturation in pulmonary tuberculosis (TB) patients with mild to moderate hypoxemia. Healthcare providers should be trained to apply this technique safely and effectively, incorporating it into routine care while closely monitoring patients for potential complications. Additionally, future research should involve larger and more diverse populations, explore long-term outcomes, and compare the effectiveness of proning with other respiratory interventions to strengthen its clinical application in various healthcare settings.

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CrediT Authorship Contributions Statement

Yeni Nur Rahmayanti: Conceptualization, Methodology, Supervision, Writing - Original Draft, Investigation, Resources, Funding Acquisition.

Yohanes Wahyu Nugroho: Software, Validation, Formal Analysis, Writing - Review & Editing, Data Curation, Project Administration

Conflicts Of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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