The Effect of Progressive Muscle Relaxation for Fatigue in a Patient with Tuberculosis and Pneumonia

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Abstract

Fatigue is a common and persistent symptom in patients with tuberculosis (TB), particularly in recurrent cases and when accompanied by pneumonia. Increased systemic inflammation and reduced activity tolerance often lead to functional decline, while pharmacological treatment alone may not sufficiently address fatigue. Progressive muscle relaxation (PMR) is a non-pharmacological intervention that reduces muscle tension and stress, support physiological recovery. This study describes the effect of PMR to reduce fatigue in a patient with recurrent tuberculosis and pneumonia. This study is a case review involving a 65-year-old female patient diagnosed with pulmonary TB and pneumonia. PMR was administered over four consecutive days, with one session lasting 15–20 minutes per session. The sessions were conducted at varying times, including in the morning, afternoon, or before bedtime. Fatigue levels were measured after each session using the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F) Scale. The patient showed improvement in vital signs, with blood pressure increasing from 108/65 mmHg to 116/61 mmHg, heart rate decreasing from 111 to 62 beats per minute, and the FACIT-F score improved from 12 (severe fatigue) to 36 (mild fatigue), indicating a reduction in fatigue severity. Functionally, the patient was able to walk to the bathroom independently and no longer experienced weakness or dyspnea post-activity. These findings indicate that PMR contributed to a reduction in the patient's fatigue level. This intervention has potential as a supportive rehabilitative strategy, with adjustments in duration and frequency based on patient condition.

Keywords: fatigue, pneumonia, progressive muscle relaxation, tuberculosis

Introduction

The uniqueness of this study lies in the persistence of fatigue during recurrent tuberculosis episodes, which continued despite prior treatment and was further aggravated by a concurrent pneumonia diagnosis. Tuberculosis (TB) is an airborne infectious disease transmitted through the respiratory tract, commonly via coughing or sneezing, caused by the Mycobacterium tuberculosis bacillus (World Health Organization, 2024). According to WHO (2024), TB has once again become the leading cause of death worldwide, with a mortality rate twice as high as that of HIV/AIDS. The highest burden of pulmonary tuberculosis (TB) is concentrated in Asia, with India, Indonesia, and China accounting for approximately 56% of global cases.

Indonesia ranks second globally, with tuberculosis recognized as the leading cause of mortality among communicable diseases (Darliana, 2015; World Health Organization, 2024). Pathologically, TB can cause structural damage to the lungs, including cavitation, fibrosis, and bronchiectasis, which may result in long-term pulmonary dysfunction (Tiberi et al., 2020). Such conditions place individuals with TB at a high risk for secondary infections, such as pneumonia.

Wei et al. (2020) reported that M. tuberculosis infection can lead to pneumonia, particularly in immunocompromised individuals. Pneumonia is an acute inflammation of lung tissue (alveoli) caused by microbial infection, leading to fluid accumulation in the alveoli and impaired gas exchange (Kumar et al., 2020). Patients with TB often present with clinical manifestations suggestive of acute pneumonia (Wei et al., 2020). In developing countries, including Indonesia, over 10% of pneumonia cases are attributable to M. tuberculosis infection (Peto et al., 2015). According to Badan Penelitian dan Pengembangan Kesehatan RI (2019) as cited by Yuskawati et al. (2024), the prevalence of pneumonia in Indonesia has increased to 2%, with morbidity among adults reaching 8.4%. Common symptoms of pneumonia include fever, cough, chest pain, shortness of breath, and weight loss (WHO, 2023). Consequently, individuals with TB and pneumonia experience a significant decline in overall health, often leading to fatigue, a key nursing problem that interferes with patient's activity and mobility.

Fatigue in patients with TB and pneumonia arises due to the physiological burden of the disease on physical activity. Fatigue is defined as a decrease in physical and mental capacity that is not alleviated by rest (PPNI, 2017). This condition results from the immune system's response to infection and systemic inflammation, which increases the production of proinflammatory cytokines affecting the central nervous system leading to fatigue, fever, and loss of appetite (Kumar et al., 2020). Decreased appetite, coupled with elevated basal metabolism from chronic infection, contributes to weight and muscle mass loss, exacerbating fatigue (Kumar et al., 2020). Furthermore, secondary pneumonia increases the inflammatory load, causing a spike in cytokine production that worsens fatigue (Kumar et al., 2020; Mason et al., 2016).

If left unmanaged, fatigue can significantly affect physiological function, psychological well-being, independence, and quality of life, limiting patient's ability to perform daily activities. Therefore, rehabilitative interventions are crucial to optimize functional capacity and support recovery, particularly in patients with chronic respiratory infections such as tuberculosis and pneumonia. Several non-pharmacological approaches have been proposed, including cognitive therapy, physical or aerobic exercise, and breathing exercises. Cognitive therapy may help address fatigue related to psychological distress. However, it requires regular sessions with trained mental health professionals and may be less feasible in acute or resource-limited settings (Hofmann et al., 2019). Physical or aerobic exercise has demonstrated benefits in improving endurance and muscle strength, but it may be unsuitable for patients experiencing severe fatigue, as increased energy expenditure may exacerbate symptoms and compromise recovery (Gloeckl et al., 2020; Tiberi et al., 2020).

Breathing exercises are commonly used in pulmonary rehabilitation and primarily aim to improve ventilation and oxygenation.

However, fatigue in patients with pulmonary tuberculosis and pneumonia is predominantly associated with muscle weakness, reduced activity tolerance, and physical deconditioning rather than respiratory impairment alone (McCarthy et al., 2015). Consequently, the impact of breathing exercises on fatigue is largely indirect and supportive, mediated through improved oxygenation and reduced anxiety (WHO, 2022).

Among available non-pharmacological interventions, progressive muscle relaxation was selected because it directly targets the physiological components of fatigue by reducing muscle tension and promoting neuromuscular relaxation (Huang et al., 2022). In addition, rehabilitation in TB and pneumonia cases often includes progressive muscle relaxation, which has been shown to reduce fatigue and support physiological recovery (Akkerman et al., 2020; Aytaç et al., 2024; Gloeckl et al., 2020; Tiberi et al., 2020; Aytaç et al., 2024). This intervention may modulate inflammatory responses, regulate the hypothalamic–pituitary–adrenal (HPA) axis, and provide additional benefits such as stress and muscle tension reduction (Elrefaey et al., 2022; Huang et al., 2022). Progressive muscle relaxation is a safe and simple intervention that can be effectively guided by nurses as part of individualized nursing care, supporting holistic recovery in patients with tuberculosis and pneumonia.

Based on this background, optimal rehabilitative management using progressive muscle relaxation is recommended to manage fatigue in TB patients. This case study presents a 65-year-old woman diagnosed with recurrent tuberculosis and pneumonia, with the aim of evaluating the effectiveness of progressive muscle training in managing her fatigue symptoms.

Research Method

This study employed a descriptive observational design in the form of a case review. Data were collected in November 2024 at the internal medicine inpatient unit of a hospital in Sumedang Regency, involving a 65-year-old female patient with tuberculosis and pneumonia. The patient had a history of tuberculosis (TB) in 2018 and completed a 7-month course of anti-tuberculosis treatment (ATT). In 2019, she experienced a relapse and underwent a second ATT for 9 months, which was not completed due to perceived recovery and treatment-related fatigue. In 2024, the patient developed recurrent TB and was hospitalized. During each episode of TB, she consistently experienced persistent fatigue but did not undertake any specific interventions to manage this symptom.

Data were gathered through observation and interviews with both the patient and her family. This was followed by clarification with the attending nurse and verification against data from the hospital's electronic medical records. The nursing assessment questionnaire for medical-surgical patients, developed by the Faculty of Nursing, Universitas Padjadjaran, was used as the primary data collection instrument.

In this study, the progressive muscle relaxation intervention was administered over a four-day period, with each session lasting approximately 15–20 minutes. The sessions were conducted once daily at varying times (before bedtime, in the morning, or in the afternoon). The PMR protocol consisted of ten sequential muscle movements performed gradually from the lower to the upper body to prevent excessive strain on the accessory respiratory muscles and minimize the risk of dyspnea and fatigue. The movements included muscle contraction and relaxation of the feet, calves, thighs, buttocks, hands, forearms, upper arms, shoulders, neck, and facial muscles. Breathing-holding maneuvers involving the chest and abdominal muscles were omitted due to the patient's pulmonary tuberculosis condition, as such maneuvers could exacerbate shortness of breath and increase energy expenditure. Evaluation indicators included blood pressure, pulse rate, and fatigue level scores. Blood pressure and pulse rate were assessed before and after each session, while fatigue levels were measured daily using the Functional Assessment Chronic Illness Therapy (FACIT) Fatigue Scale throughout the intervention period.

The study was conducted after obtaining permission from the hospital and nursing staff, as well as written informed consent from the patient and her family. The informed consent process ensured that the patient and

her family were fully aware of the study's purpose and procedures before signing the consent form. Data analysis was carried out using narrative analysis to interpret and synthesize the findings obtained during the study.

Results

Mrs. E, a 65-year-old woman, was admitted to the internal medicine inpatient unit with a medical diagnosis of Tuberculosis and Pneumonia. She presented to the hospital on November 20, 2024, with complaints of sudden-onset hematemesis (vomiting blood) and full-body tremors, rendering her unable to stand or perform daily activities. The patient had a history of TB in 2018 and had completed a 7-month course of anti-tuberculosis treatment (ATT). However, in 2019, her TB relapsed, requiring another course of ATT for 9 months, which she failed to complete due to a perception of recovery and treatment fatigue from the longer regimen compared to her previous experience. In 2024, the patient experienced a recurrence of TB, and during hospitalization, she developed pneumonia as a complication. The patient and her family stated that there was no family history of similar illness. On assessment conducted on November 21, 2024, the patient reported generalized weakness that was not relieved by rest. She was unable to get up or reposition herself in bed. The fatigue was accompanied by shortness of breath, nausea, loss of appetite, and a productive cough that had persisted for the past three weeks. The patient was alert and compos mentis, with a Glasgow Coma Scale score of E4V5M6. Her general condition appeared weak. Vital signs were as follows: blood pressure 108/65 mmHg, heart rate 111 beats per minute, respiratory rate 23 breaths per minute, oxygen saturation 96% via nasal cannula at 5 L/min, and body temperature 36.1°C. Physical examination revealed symmetrical chest expansion, use of accessory muscles during respiration, shallow and rapid breathing rhythm, diminished breath sounds, and rhonchi in both lung fields (+). Tremors were noted in both upper extremities (+/+), and muscle strength was graded at 4/4 in all limbs. Fatigue was measured using the Functional Assessment of Chronic Illness Therapy (FACIT) Fatigue Scale, with a score of 12, indicating severe fatigue. Laboratory results showed: hemoglobin 16.2 g/dL, hematocrit 50%, leukocyte count 9,070/mm³, platelet count 56,000/mm³, creatinine 1.4 mg/dL, random blood glucose 100 mg/dL, sodium 128 mmol/L, potassium 4.3 mmol/L, and calcium 8.3 mg/dL. Chest radiograph (photo thorax) taken on November 20, 2024, revealed bilateral bronchopneumonia DD active pulmonary tuberculosis.

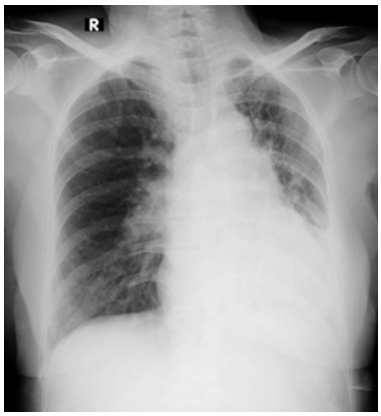

Figure 1. Photo Thorax Result

The patient received pharmacological therapy consisting of Combivent and Pulmicort administered via nebulized inhalation three times daily; Infimycin 0.5 g intravenously once daily; Ambroxol 30 mg orally three times daily; Omeprazole 4 mg intravenously twice daily; Methylprednisolone 62.5 mg intravenously twice daily; Cefotaxime 1 g intravenously twice daily; and ATT.

This case presented several nursing diagnoses based on the patient's condition. However, the main focus of care was on problems related to activity and rest. Therefore, the priority nursing diagnosis in this case was fatigue related to physiological condition: chronic illness, as evidenced by the patient's complaints of generalized weakness, feeling exhausted and short of breath during and after movement, fatigue unrelieved by rest, reduced appetite, elevated pulse rate (111 bpm), poor general condition, dependence on family for activities, positive tremor in upper extremities (+/+), and a FACIT Fatigue Scale score of 12, indicating severe fatigue.

The nursing intervention provided to address this issue focused on activity

management through progressive muscle relaxation. The patient underwent progressive muscle relaxation sessions for four consecutive days, each lasting 15–20 minutes. The intervention was accompanied by education encouraging the patient to gradually resume physical activity and to repeat the exercises in the morning, afternoon, or before bedtime.

Nursing evaluation, particularly related to fatigue, was conducted using the FACIT Fatigue Scale and by monitoring the patient's pulse rate and blood pressure daily following each progressive muscle relaxation session. The following table presents the results of fatigue level, pulse rate, and blood pressure measurements over the four-day intervention period.

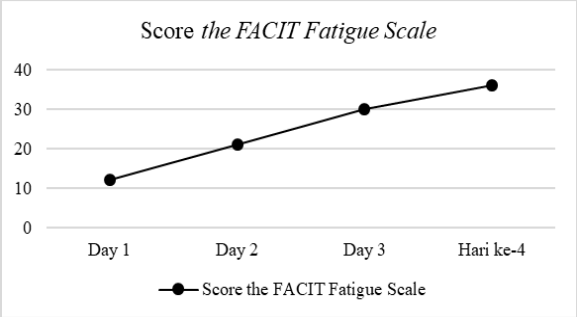

Figure 2. Fatigue Level Based on the FACIT Fatigue Scale

Interpretation

- Score < 30 : Severe fatigue
- Score ≥ 30 : Mild fatigue and improved quality of life

(Tennant, 2019).

Table 1. Pulse Rate and Blood Pressure Measurements Before and After Progressive Muscle Relaxation Intervention

Indicators	Day							
	1		2		3		4	
	Before	After	Before	After	Before	After	Before	After
Heart Rate (bpm)	111	101	63	60	72	69	64	62
Blood Pressure (mmHg)	108/65	110/70	100/60	100/80	100/70	110/80	110/60	116/61

Subjective data from the patient indicated a noticeable reduction in overall body weakness, with the patient reported being able to walk to the bathroom independently and no longer experienced shortness of breath or fatigue following activity. No adverse effects or signs of clinical deterioration were observed during the intervention. As shown in Table 1 and Figure 2, the patient's pulse rate and blood pressure values improved and remained within the normal range during the last three days of intervention. This improvement aligns with the fatigue level trend based on the FACIT Fatigue Scale, which demonstrated a consistent increase in fatigue scores, indicating a decrease in fatigue severity. On Day 3 and Day 4, the patient's fatigue levels continued to improve, as reflected by increasing FACIT scores. The FACIT Fatigue Scale ranges from 0 to 52. Initially, the patient's score was 21, indicating severe fatigue. After four consecutive days of progressive muscle relaxation, the score improved to 36 (≥30), suggesting reduced fatigue and an improvement in quality of life (Tennant, 2019). In addition, on the final day of intervention, physical examination showed no tremors in the upper extremities (-/-), and the patient was able to perform daily activities independently with minimal assistance.

Discussion

The clinical manifestations of pulmonary tuberculosis (TB) typically develop gradually and are often nonspecific. Fatigue is among the most common nursing problems found in patients with pulmonary TB and pneumonia (Luies & Preez, 2020). Lin et al. (2021), cited in Aytaç et al. (2024), reported that nearly half (47%) of patients with pulmonary TB, both undergoing and having completed treatment, experiences fatigue. The level of fatigue is closely linked to the production of proopiomelanocortin (POMC), a precursor hormone secreted by the anterior pituitary gland. Chronic infection and inflammation in TB patients induce stress, activating the

hypothalamic-pituitary-adrenal (HPA) axis and stimulating the release of corticotropin-releasing hormone (CRH). This leads to increased production of POMC, which is then cleaved into adrenocorticotropic hormone (ACTH) and β-endorphin. Both contribute to elevated cortisol levels, which, over time, can result in metabolic disturbances and exacerbate fatigue (Özlü et al., 2021). According to Thedthong et al. (2021), fatigue is the most frequently reported clinical manifestation among patients with pulmonary TB and affects the quality of life in up to 88% of cases. Additionally, patients with both TB and pneumonia often present with symptoms that interfere with daily activities, leading to a significant decline in their overall quality of life (Tiberi et al., 2020). This highlights the urgency of managing fatigue, as it is one of the most common and impactful symptoms of TB and pneumonia.

In this case, progressive muscle relaxation was implemented as a nursing intervention to manage fatigue. The evaluation results showed that the patient reported a reduction in overall body weakness, and the FACIT Fatigue Scale scores also reflected this improvement. Aytaç et al. (2024) found that progressive muscle relaxation significantly reduce levels of proinflammatory cytokines such as interleukin-1 (IL-1), interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), and cortisol, which are directly associated with fatigue in patients. In their study, the intervention group showed a significant reduction in fatigue after one month of progressive muscle relaxation, with average fatigue scores decreasing from 8.29 to 6.83. Similarly, Kaplan Serin, et al. (2020) as cited in Elrefaey et al. (2022), also demonstrated that progressive muscle relaxation reduced fatigue levels in patients with chronic illnesses, marked by lower fatigue scores. The intervention has been shown to improve mitochondrial function and muscle metabolism, both of which are essential for efficient energy production. As energy production becomes more efficient, fatigue decreases (Tiberi et al., 2020). According to Huang et al. (2022), progressive muscle relaxation also suppresses HPA axis activity, reducing the production of CRH and POMC, and thus stabilizing cortisol and β-endorphin levels. This hormonal balance contributes to better sleep quality, mood, and overall comfort, thereby reducing physical fatigue. These findings are consistent with the evaluation results in this case, where the patient's subjective reports indicated reduced fatigue, and objective measurements showed improved fatigue scores following the intervention.

Another evaluation finding that supports the patient's improvement following the progressive muscle relaxation intervention was the patient's ability to walk to the bathroom and perform daily activities independently with minimal assistance. This increase in functional independence reflects one of the positive outcomes of progressive muscle relaxation, particularly its impact on muscle strength. As a rehabilitative intervention, progressive muscle relaxation has been shown to reduce dyspnea during physical activity and enhance patients activity tolerance (Elrefaey et al., 2022). Through gradual and structured muscle stimulation, this intervention indirectly strengthens muscle function, thereby enabling patients to perform daily tasks with less effort (Tiberi et al., 2020). Rovsing et al. (2021) found that progressive muscle relaxation can reduce muscle stiffness and fatigue while improving physical fitness in patients with pulmonary tuberculosis and pneumonia. These findings are consistent with those of Boedecker et al. (2020), who emphasized that progressive muscle relaxation can serve as an effective therapeutic method to alleviate fatigue and increase activity tolerance. Therefore, the implementation of progressive muscle relaxation as a rehabilitative measure has the potential to significantly improve the quality of life in patients.

Several studies have demonstrated that progressive muscle relaxation has a positive impact on the quality of life in patients with pulmonary tuberculosis (TB) and pneumonia. According to Aytaç et al. (2024), fatigue in TB and pneumonia patients significantly affects their overall quality of life. In their study, progressive muscle relaxation was proven to reduce fatigue levels, thereby improving patients quality of life. Other studies have also shown a linear relationship between improved quality of life and decreased fatigue levels in

TB and pneumonia patients (Kaplan Serin et al., 2020). This is supported by findings from Elrefaey et al. (2022), which reported a statistically significant improvement in physical function and patients ability to carry out daily activities following progressive muscle relaxation, with a p-value < 0.05. These findings suggest that progressive muscle relaxation is an effective intervention to reduce fatigue in patients with pulmonary TB and pneumonia. These results are consistent with the present case evaluation, as evidenced by the patient's FACIT Fatigue Scale score reaching ≥ 30, indicating a reduction in fatigue and an improvement in quality of life (Tennant, 2019).

The effectiveness of progressive muscle relaxation as an intervention is influenced by several factors, particularly the timing, frequency, and duration of the sessions during hospitalization. Studies have demonstrated considerable variation in these parameters, with interventions ranging from three days to twelve weeks and session durations between 15 to 45 minutes. For instance, Widayani & Aprillia (2024) implemented a three-day intervention with 15–20 minute sessions, resulting in a reduction in fatigue from severe or moderate to mild levels. Similarly, Aytaç, et al. (2024) reported a significant decrease in fatigue scores ($p < 0.05$) following four weeks of training, conducted three times per week for 30 minutes. Elrefaey et al. (2022) found that a one-month program involving two 45-minute sessions per day led to improved quality of life in 55% of participants. Kaplan Serin et al. (2020) also observed a significant reduction in severe fatigue ($p < 0.01$) after six weeks of 30-minute sessions. The longest duration was reported by Boedecker et al. (2020), who conducted a twelve-week intervention with sessions lasting 20 to 45 minutes, resulting in enhanced activity tolerance. Despite variations in protocol, all studies consistently support the effectiveness of progressive muscle relaxation in reducing fatigue and improving functional outcomes in patients with tuberculosis and pneumonia.

The nursing intervention implemented in this case successfully alleviated symptoms and proved effective in enhancing the patient's quality of life. A number of studies have shown that progressive muscle relaxation consistently reduces fatigue levels, regardless of the intervention's frequency and duration (Aytaç et al., 2024; Boedecker et al., 2020; Kaplan Serin et al., 2020; Widayani and Aprillia, 2024). The effectiveness of this intervention is largely influenced by the regularity of exercise, the body's physiological adaptation to physical activity, and improvements in the patient's functional capacity. Notably, the benefits of progressive muscle relaxation extend beyond physical improvement, contributing to overall well-being and quality of life in a holistic manner (Elrefaey et al., 2022; Kaplan Serin et al., 2020). Therefore, progressive muscle relaxation can be considered a practical and effective therapeutic approach in managing fatigue among patients with tuberculosis and pneumonia.

Implications and Limitations

This case study highlights the clinical relevance of progressive muscle relaxation as an effective non-pharmacological intervention to manage fatigue and improve functional capacity and quality of life in patients with tuberculosis and pneumonia. The findings support the integration of rehabilitative nursing interventions, particularly muscle-strengthening exercises, into routine inpatient care for patients experiencing fatigue due to chronic infectious diseases. The results also emphasize the importance of a holistic nursing approach that addresses not only the physiological, but also the functional and psychological needs of the patient.

Although the intervention in this case was delivered over a short period (four days), it aligns with findings from previous studies that have demonstrated improvements in fatigue levels across both short-term and long-term implementations. However, as a single-case observational design, this study carries inherent limitations in terms of generalizability. Patient-specific variables, such as comorbidities, nutritional status, or baseline physical condition, may influence the effectiveness of the intervention. Additionally, the lack of long-term follow-up limits the understanding of sustained outcomes over time. Future research involving larger sample sizes, diverse patient

populations, and extended monitoring is recommended to strengthen the evidence base and guide clinical practice more broadly.

Conclusion

Fatigue was identified as the primary symptom in this case, prompting the implementation of progressive muscle relaxation as the main intervention. The intervention was implemented over four consecutive days, with one session per day lasting 15–20 minutes. Following the intervention, improvements were observed in the patient's vital signs, including an increase in blood pressure from 108/65 mmHg to 116/61 mmHg and a reduction in heart rate from 111 bpm to 62 bpm. Additionally, tremors in the upper extremities subsided. The patient also reported reduced fatigue and was able to perform daily activities more independently, which was consistent with improved scores on the FACIT Fatigue Scale. Both the patient and family expressed positive perceptions of the intervention, reporting improved comfort, ease of implementation, and increased confidence in managing fatigue. The effectiveness of this intervention underscores the importance of consistency in its application. Whether guided by a nurse or performed independently by the patient, regular engagement in progressive muscle exercises is essential. Therefore, based on the findings of this study, progressive muscle training can be considered a practical strategy for managing fatigue in patients with tuberculosis and pneumonia, with appropriate adjustments to session duration and frequency.

References

Akkerman, O. W., ter Beek, L., Centis, R., Maeurer, M., Visca, D., Muñoz-Torrico, M., Tiberi, S., & Migliori, G. B. (2020). Rehabilitation, optimized nutritional care, and boosting host internal milieu to improve long-term treatment outcomes in tuberculosis patients. *International Journal of Infectious Diseases*, 92, S10–S14. https://doi.org/10.1016/j.ijid.2020.01.029

Aytaç, S., Ovayolu, Ö., & Dogru, S. (2024). The effect of breathing exercises on fatigue in tuberculosis patients: a randomized controlled trial. *Revista Da Associacao Medica Brasileira*, 70(12), 1–6. https://doi.org/10.1590/1806-9282.20240888

Badan Penelitian dan Pengembangan Kesehatan RI. (2019). *Laporan Riskesdas 2018 Nasional.* In Lembaga Penerbit Balitbangkes. https://repository.badankebijakan.kemkes.go.id/id/eprint/3514/1/Laporan Riskesdas 2018 Nasional.pdf

Boedecker, S. C., Philippi, K. F. A., Neuberger, E., Schmidt, S., Pfirrmann, D., Haller, N., Schwarting, A., Simon, P., & Weinmann-Menke, J. (2020). Twelve-Week Internet-Based Individualized Exercise Program in Adults With Systemic Lupus Erythematosus: Protocol for a Randomized Controlled Trial. *JMIR Research Protocols*, 9(11), e18291. https://doi.org/https://doi.org/10.2196/18291

Darliana, D. (2015). *Manajemen Pasien Tuberkulosis Paru*. PSIK – FK Unsyiah, 2(1), 27–31.

Elrefaey, N., Harfoush, M., & Abdelaty, H. (2022). Effect of Progressive Muscle Relaxation Technique on Quality of Life and Fatigue Severity among Systemic Lupus Erythematosus Patients'. *Egyptian Journal of Health Care*, 13(3), 2100–2118. https://doi.org/10.21608/ejhc.2022.295779

Gloeckl, R., Schneeberger, T., Jarosch, I., & Kenn, K. (2020). Pulmonary rehabilitation and exercise training in chronic obstructive pulmonary disease. *Deutsches Arzteblatt International*, 115(8), 117–123. https://doi.org/10.3238/arztebl.2018.0117

Hofmann, S. G., Asnaani, A., Vonk, I. J. J., Sawyer, A. T., & Fang, A. (2019). The efficacy of cognitive behavioral therapy: A review of meta-analyses. *Cognitive Therapy and Research*, 43(1), 427–440. https://doi.org/10.1007/s10608-012-9476-1

Huang, L., Zhou, M., Xu, E., & Xu, Y. (2022). Effect of progressive muscle relaxation training on psychological health in patients with chronic infectious disease: A systematic

review and meta-analysis. *International Journal of Nursing Studies*, 132, 104–110. https://doi.org/https://doi.org/10.1016/j.ijnurstu.2022.104260

Kaplan Serin, E., Ovayolu, N., & Ovayolu, Ö. (2020). The Effect of Progressive Relaxation Exercises on Pain, Fatigue, and Quality of Life in Dialysis Patients. *Holistic Nursing Practice*, 34(2), 121–128. https://doi.org/10.1097/HNP.0000000000000347

Kumar, V., Abbas, A. K., & Aster, J. C. (2020). *Robbins & Cotran Pathologic Basis of Disease* (10th Editi). Elsevier.

Lin, Y., Liu, Y., Zhang, G., Cai, Q., Hu, W., Xiao, L., Thekkur, P., Golub, J. E., & Harries, A. D. (2021). Is it feasible to conduct post-tuberculosis assessments at the end of tuberculosis treatment under routine programmatic conditions in China? *Tropical Medicine and Infectious Disease*, 6(3), 1–12. https://doi.org/10.3390/TROPICALMED6030164

Luies, L., & Preez, I. du. (2020). The echo of pulmonary tuberculosis: Mechanisms of clinical symptoms and other disease-induced systemic complications. *Clinical Microbiology Reviews*, 33(4), 1–19. https://doi.org/10.1128/CMR.00036-20

Mason, R. J., Slutsky, A., Murray, J. F., Nadel, J. A., & Gotway, M. B. (2016). Murray & Nadel's Textbook of Respiratory Medicine (6th Editio). *Elsevier*. https://doi.org/10.1016/C2011-1-08123-7

McCarthy, B., Casey, D., Devane, D., Murphy, K., Murphy, E., & Lacasse, Y. (2015). Pulmonary rehabilitation for chronic obstructive pulmonary disease. *Cochrane Database of Systematic Reviews*, 2, CD003793. https://doi.org/10.1002/14651858.CD003793.pub3.www.cochranelibrary.com

Özlü, İ., Öztürk, Z., Karaman Özlü, Z., Tekin, E., & Gür, A. (2021). The Effects of Progressive Muscle Relaxation Exercises on the Anxiety and Sleep Quality of Patients with COVID-19: A Randomized Controlled Study. *Perspectives in Psychiatric Care,* 57(4), 1791–1797. https://doi.org/10.1111/ppc.12750

Peto, L., Nadjm, B., Horby, P., Ngan, T. T. D., van Doorn, R., Van Kinh, N., & Wertheim, H. F. L. (2015). The bacterial aetiology of adult community-acquired pneumonia in Asia: A systematic review. *Transactions of the Royal Society of Tropical Medicine and Hygiene,* 108(6), 326–337. https://doi.org/10.1093/trstmh/tru058

PPNI. (2017). *Standar Diagnosis Keperawatan Indonesia: Definisi dan Indikator Diagnostik* (Edisi 1 Ce). PPNI.

Rovsing, C., Rovsing, H., Liboriussen, C., Jensen, M., Andersen, S., & Kristensen, S Jochumsen, M. (2021). Deep Breathing Increases Heart Rate Variability in Patients With Rheumatoid Arthritis and Systemic Lupus Erythematosus. *Journal of Clinical Rheumatology : Practical Reports on Rheumatic & Musculoskeletal Diseases,* 27(7), 261–266. https://doi.org/https://doi.org/10.1097/RHU.0000000000001300

Tennant, K. F. (2019). Assessment of Fatigue in Older Adults: The FACIT Fatigue Scale (Version 4). *The Hartford Institute for Geriatric Nursing, New York University Rory Meyers College of Nursing*, 10(30).

Thedthong, W., Puwarawuttipanit, W., Saneha, C., & Rongrungruang, Y. (2021). Factors Predicting Fatigue in Pulmonary Tuberculosis Patients Receiving Anti-Tuberculosis Drugs. *Siriraj Medical Journal*, 73(3), 167–173. https://doi.org/10.33192/Smj.2021.22

Tiberi, S., Torrico, M. M., Rahman, A., Krutikov, M., Visca, D., Silva, D. R., Kunst, H., & Migliori, G. B. (2020). Managing severe tuberculosis and its sequelae: From intensive care to surgery and rehabilitation. *Jornal Brasileiro de Pneumologia*, 45(2), 1–9. https://doi.org/10.1590/1806-3713/e20180324

Wei, M., Yongjie Zhao, Zhuoyu Qian, Biao Yang, Xi, J., Wei, J., & Tang, B. (2020).

Pneumonia caused by Mycobacterium tuberculosis. *Microbes and Infection*, 22(6–7), 278–284. https://doi.org/10.1016/j.micinf.2020.05.020

Widayani, R., & Aprillia, Z. (2024). *Asuhan Keperawatan Relaksasi Otot Progresif untuk Mengatasi Keletihan pada Anak dengan Systemic Lupus Erythematosus (SLE).* Seminar Nasional Keperawatan "Optimalisasi Praktik Keperawatan Dewasa: Pendekatan Paliatif Dalam Mengelola Diabetes Mellitus Untuk Meningkatkan Kualitas Hidup" Tahun 2024.

World Health Organization. (2022). WHO consolidated guidelines on tuberculosis. *In WHO Press*. World Health Organization.

World Health Organization. (2023). *Pneumonia.* WHO. https://www.who.int/news-room/fact-sheets/detail/pneumonia

World Health Organization. (2024). *Global Tuberculosis Report 2024.* World Health Organization.

Yuskawati, D., Astuty, D. A., & Wahyudi, W. (2024). Faktor-Faktor yang Berhubungan dengan Length of Stay Pasien Pneumonia di Rumah Sakit Umum Haji Medan. *MAHESA : Malahayati Health Student Journal*, 4(5), 1649–1664. https://doi.org/10.33024/mahesa.v4i5.14541