JUKEKE Jurnal Kesehatan dan Kedokteran
OPEN ACCESS
JUKEKE Vol 5 No. 1 | February 2026 | ISSN: 2829-0437 (Print), ISSN: 2829-050X (online), Page 432-444

Respiratory Physiotherapy Management in Pediatric Bronchial Asthma

Dika Apriani[1], Wahyu Tri Sudaryanto[2], Fatonah Sulistyowati[3]
[1,2] Profesi Fisioterapi Fakultas Ilmu Kesehatan, Universitas Muhammdiyah Surakarta, Indonesia
[3] Fisioterapis, Instalasi Rehabilitasi Medik RSUP Surakarta, Indonesia

Article History
Received : February 27, 2026
Revised : March 02, 2026
Accepted : March 05, 2026
Published : March 06, 2026

Corresponding author*:
wts831@ums.ac.id

Cite This Article *[APA Style]:*
Apriani, D., Sudaryanto, W. T., & Sulistyowati, F. (2025). Respiratory Physiotherapy Management in Pediatric Bronchial Asthma. *Jurnal Kesehatan Dan Kedokteran*, *5*(1), 445–458.

DOI:
https://doi.org/10.56127/jukeke.v5i1.2636

Abstrak: Bronchial asthma is a chronic inflammatory disease of the respiratory tract characterized by airway narrowing, bronchial hyperresponsiveness, and reversible airflow limitation. This condition may cause symptoms such as dyspnea, coughing, wheezing, and reduced functional activity capacity, particularly in pediatric patients. Therefore, supportive interventions such as respiratory physiotherapy are important to improve respiratory function and reduce asthma symptoms. **Objective:** This study aims to describe the effectiveness of respiratory physiotherapy management in a pediatric patient with bronchial asthma treated at RSUP Surakarta and to highlight the role of physiotherapy as a complementary intervention in improving respiratory function. **Method:** This study used a qualitative case report design involving a five-year-old boy diagnosed with bronchial asthma. Data were collected through clinical examination and repeated evaluations during five physiotherapy sessions, including thoracic expansion measurement, peak expiratory flow assessment, auscultation examination, vital sign monitoring, and dyspnea assessment using the Borg Scale and the Modified Medical Research Council (mMRC) scale. Data were analyzed descriptively by comparing the patient's clinical condition before and after intervention across treatment sessions. **Findings:** The results showed improvement in several respiratory indicators after the intervention. Thoracic expansion increased at all measurement points, peak expiratory flow improved from 200 L/min to 550 L/min, and breath sounds changed from wheezing and rhonchi to normal vesicular sounds. In addition, vital signs showed improvement and perceived dyspnea decreased based on the Borg Scale, although the mMRC score remained unchanged. **Implications:** These findings suggest that respiratory physiotherapy may contribute to improving ventilation, chest wall mobility, and respiratory efficiency in pediatric asthma patients. Physiotherapy interventions can therefore be considered as supportive therapy in comprehensive asthma management. **Originality:** The originality of this study lies in the detailed clinical documentation of multimodal respiratory physiotherapy interventions in a pediatric bronchial asthma case, particularly in evaluating changes in thoracic expansion, peak expiratory flow, auscultation findings, and dyspnea during repeated treatment sessions.

Keywords: Bronchial Asthma; Respiratory Physiotherapy; Nebulizer; Breathing Exercise; Thoracic Expansion.

INTRODUCTION

Bronchial asthma is one of the most prevalent chronic respiratory diseases worldwide and represents a major public health concern, particularly among children. The disease is characterized by chronic airway inflammation, bronchial narrowing, airway

hyperresponsiveness, and reversible airflow limitation that can lead to symptoms such as wheezing, coughing, chest tightness, and shortness of breath (Koefoed et al., 2021; Martin et al., 2022). In pediatric populations, asthma not only affects respiratory health but may also interfere with sleep quality, physical activity, school attendance, and social participation, thereby significantly affecting children's overall quality of life. Recurrent exacerbations and persistent respiratory symptoms may also increase healthcare utilization and long-term morbidity in children with asthma.

Globally, asthma continues to contribute substantially to the burden of non-communicable diseases. According to epidemiological data, asthma affected approximately 262 million people worldwide in 2019 and caused more than 455,000 deaths (Dharmage et al., 2019; World Health, 2024). Asthma is also ranked among the leading causes of years lived with disability (DALYs), particularly in pediatric populations. Despite advances in pharmacological therapies and improved clinical guidelines, many patients still experience inadequate asthma control. Studies report that more than 50% of patients with moderate to severe asthma continue to experience persistent symptoms and exacerbations even after receiving standard pharmacological treatment (Agus, 2018; Global Initiative for, 2024; Jayakumaran et al., 2020). This situation highlights the need for comprehensive management strategies that combine pharmacological therapy with supportive non-pharmacological interventions to improve respiratory function and quality of life.

Previous research on asthma management has largely focused on pharmacological treatment and guideline-based clinical approaches. Several studies emphasize the importance of bronchodilators, inhaled corticosteroids, and nebulizer therapy in controlling airway inflammation, reducing bronchospasm, and preventing asthma exacerbations (Martin et al., 2022; Rovsing et al., 2023). Nebulizer therapy in particular allows medication to be delivered directly into the respiratory tract in aerosol form, facilitating faster onset of action and improved airway penetration (Bosch et al., 2022). While pharmacological interventions remain the primary treatment strategy, evidence suggests that medication alone may not always achieve optimal asthma control in all patients.

A second group of studies has examined non-pharmacological interventions, particularly breathing exercises and respiratory rehabilitation techniques, as supportive treatments in asthma management. Techniques such as pursed-lip breathing, diaphragmatic breathing, and deep breathing exercises have been shown to improve ventilation efficiency,

reduce respiratory rate, enhance lung capacity, and decrease dyspnea in patients with respiratory disorders (Herawati, Fitri, et al., 2023; Herawati, Hakim, et al., 2023; Zulkifli, 2022). These interventions are believed to improve breathing patterns, reduce air trapping, and enhance respiratory muscle efficiency, which may contribute to improved pulmonary function and symptom control.

Another area of research focuses on respiratory physiotherapy and respiratory muscle-related interventions, including thoracic expansion exercises, chest wall mobilization, and myofascial release techniques. These interventions aim to improve chest wall mobility, reduce muscle tension in accessory respiratory muscles, and optimize respiratory mechanics (Dewi et al., 2023; Fregonezi & Llurda-Almuzara, 2023; Tongtako, 2024). Although these studies suggest potential benefits of physiotherapy in improving respiratory performance, much of the existing evidence is derived from experimental studies, systematic reviews, or adult populations. Detailed clinical documentation of combined physiotherapy interventions in pediatric bronchial asthma patients in real-world clinical settings remains relatively limited. In addition, only a few studies have reported comprehensive clinical outcomes such as thoracic expansion, peak expiratory flow, auscultation findings, vital signs, and dyspnea scale changes following a multimodal physiotherapy program.

Based on these gaps in the literature, this study aims to analyze the effectiveness of respiratory physiotherapy management in a pediatric patient with bronchial asthma through a clinical case report conducted at RSUP Surakarta. The intervention includes a combination of nebulizer therapy, myofascial release, pursed-lip breathing, deep breathing exercise, and thoracic expansion exercise. The patient's response to the intervention is evaluated using several clinical parameters, including thoracic expansion measurement, peak expiratory flow values, auscultation findings, vital signs, and dyspnea assessment using the Borg Scale and the Modified Medical Research Council (mMRC) scale. Through systematic monitoring of these parameters during multiple treatment sessions, this study seeks to provide practical clinical evidence regarding the potential contribution of respiratory physiotherapy as an adjunctive treatment in pediatric asthma management.

This study is based on the argument that a structured combination of nebulizer therapy and respiratory physiotherapy interventions may improve ventilatory function and respiratory clinical outcomes in pediatric patients with bronchial asthma. Nebulizer therapy facilitates effective drug delivery into the airway to reduce bronchospasm and airway

inflammation, while physiotherapy techniques such as breathing exercises, thoracic expansion exercises, and myofascial release may enhance chest wall mobility, improve breathing patterns, reduce accessory respiratory muscle tension, and increase pulmonary airflow capacity (Bosch et al., 2022; Idea et al., 2025; Rajab et al., 2025). Therefore, the working hypothesis of this study is that the implementation of a multimodal respiratory physiotherapy program may be associated with improvements in thoracic expansion, peak expiratory flow, breath sound quality, and perceived dyspnea in a pediatric patient with bronchial asthma receiving outpatient physiotherapy treatment.

RESEARCH METHOD

The unit of analysis in this study was a pediatric patient diagnosed with bronchial asthma who received physiotherapy management at RSUP Surakarta. The subject of the study was a five-year-old male patient who presented with complaints of shortness of breath accompanied by wheezing, particularly during physical activity and exposure to cold air, with symptoms often occurring during the early morning hours. The patient also had a family history of asthma from both his mother and grandmother. The focus of the analysis was the patient's respiratory clinical condition and its changes following physiotherapy intervention, which were evaluated through several clinical indicators, including thoracic expansion, peak expiratory flow values, auscultation findings, vital signs, and dyspnea assessment.

This study employed a qualitative clinical case report design. The case report approach was selected because it allows for an in-depth description of the clinical condition of a patient and the response to therapeutic interventions in real-world clinical practice. This design is commonly used in medical and physiotherapy research to document the effectiveness of specific interventions and provide detailed clinical insights that may contribute to evidence-based practice. By using a case report approach, the study was able to observe the progression of respiratory function and symptom improvement during multiple physiotherapy sessions.

The data used in this study consisted of primary clinical data obtained directly from the patient during physiotherapy treatment sessions at RSUP Surakarta. These data included physiological and functional measurements such as vital signs, thoracic expansion measurements, peak expiratory flow values obtained using a peak flow meter, auscultation findings, and dyspnea assessments using the Borg Scale and the Modified Medical

Research Council (mMRC) scale. Additional supporting information regarding the patient's medical history, symptoms, and triggering factors was obtained through clinical observation and patient history records documented during the treatment process.

Data collection was conducted through a series of clinical examinations and physiotherapy evaluations performed before and after each treatment session. The assessment began with the measurement of vital signs, including blood pressure, respiratory rate, heart rate, body temperature, and oxygen saturation. This was followed by physical examination through inspection, palpation, and auscultation of the thoracic region to identify breathing patterns, chest expansion characteristics, and abnormal breath sounds. Thoracic expansion was measured at several anatomical landmarks to evaluate chest wall mobility, while peak expiratory flow was assessed using a peak flow meter to determine the patient's expiratory airflow capacity. These measurements were recorded during five physiotherapy sessions to monitor the patient's progress throughout the intervention period.

Data analysis in this study was conducted using descriptive clinical analysis. The recorded clinical measurements from each treatment session were compared to identify changes in respiratory function and symptom severity following physiotherapy interventions. The analysis focused on observing trends in thoracic expansion, peak expiratory flow values, auscultation findings, vital signs, and dyspnea scores across the treatment sessions. The results were then interpreted in relation to the physiotherapy interventions administered, including nebulizer therapy, myofascial release, pursed-lip breathing, deep breathing exercise, and thoracic expansion exercise, to evaluate the potential contribution of these interventions to the improvement of the patient's respiratory condition.

RESULT

Improvement in Thoracic Expansion and Peak Expiratory Flow

The first finding of this study concerns changes in respiratory function as reflected by thoracic expansion and peak expiratory flow measurements during five physiotherapy sessions. Thoracic expansion was measured using the midline method at three anatomical landmarks: the axillary level, intercostal level, and xiphoid process. The results showed improvement in thoracic expansion from the first to the fifth session. At the axillary level, the expansion increased by 2 cm. At the intercostal level, the value increased from 1.5 cm

at the first session to 4.5 cm at the fifth session. At the xiphoid process level, the value increased from 2 cm at the first session to 4.3 cm at the fifth session, showing an increase of 2.3 cm.

Peak expiratory flow measurements also demonstrated improvement across the five treatment sessions. The recorded values were 200 L/min at the first session, 302 L/min at the second session, 475 L/min at the third session, 500 L/min at the fourth session, and 550 L/min at the fifth session. Although the highest value was obtained at the fifth session, the final result was still reported as 54%, indicating that airway obstruction was still present.

Visualisation of Data

Table 1. Thoracic Expansion and Peak Expiratory Flow During Physiotherapy Sessions

Parameter	T1	T2	T3	T4	T5	Change
Thoracic expansion – Axillary (cm)	2.0	-	-	-	4.0	+2.0
Thoracic expansion – Intercostal (cm)	1.5	-	-	-	4.5	+3.0
Thoracic expansion – Xiphoid process (cm)	2.0	-	-	-	4.3	+2.3
Peak expiratory flow (L/min)	200	302	475	500	550	+350

The results show that chest wall expansion increased at all thoracic measurement points during the intervention period. Similarly, peak expiratory flow improved progressively from the first to the fifth session.

Several patterns can be identified from these findings. First, thoracic expansion improved at all measured levels, indicating better chest wall movement. Second, the greatest increase in thoracic expansion was observed at the intercostal level. Third, peak expiratory flow rose progressively throughout the five treatment sessions. Fourth, despite this improvement, the final peak flow result still suggested the presence of airway obstruction.

These findings indicate that the physiotherapy intervention was associated with improved respiratory mechanics and expiratory airflow. Increased thoracic expansion suggests better chest wall mobility, while the progressive increase in peak expiratory flow indicates better ability to expel air from the lungs. However, the remaining 54% value suggests that the patient had not yet achieved complete recovery of airway function.

Changes in Auscultation Findings and Vital Signs

The second finding concerns changes in clinical respiratory indicators based on auscultation findings and vital sign evaluation during the five physiotherapy sessions.

Auscultation showed progressive improvement in breath sounds. At the first session (T1), wheezing was heard at ICS 2 dextra, vesicular breath sound was heard at ICS 2 sinistra, vesicular breath sound was also present at ICS 4 dextra, while rhonchi were heard at ICS 4 sinistra. At ICS 6 on both dextra and sinistra sides, vesicular breath sounds were present. At the second session (T2), wheezing was still heard at ICS 2 dextra, while ICS 2 sinistra remained vesicular. Rhonchi were heard at ICS 4 dextra, whereas ICS 4 sinistra was vesicular. At the third session (T3), improvement was observed in several lung areas, with vesicular breath sounds heard at ICS 2 dextra and sinistra, as well as ICS 4 dextra, although wheezing was still present at ICS 4 sinistra. At the fourth session (T4), wheezing reappeared at ICS 2 dextra, rhonchi were heard at ICS 4 dextra, and other examined points remained vesicular. At the fifth session (T5), all auscultation points at ICS 2, ICS 4, and ICS 6 on both dextra and sinistra sides revealed normal vesicular breath sounds.

Vital sign evaluation from the first to the fifth session also showed changes after intervention. Based on Figure 1, the monitored parameters included heart rate (HR), oxygen saturation (SpO_2), and respiratory rate (Dharmage et al.). The graph indicates that SpO_2 showed an increasing trend across sessions, while HR and RR also changed during the intervention period.

Table 2. Summary of Auscultation Findings During Physiotherapy Sessions

Session	Auscultation Findings
T1	Wheezing at ICS 2 dextra; vesicular at ICS 2 sinistra; vesicular at ICS 4 dextra; rhonchi at ICS 4 sinistra; vesicular at ICS 6 dextra and sinistra
T2	Wheezing at ICS 2 dextra; vesicular at ICS 2 sinistra; rhonchi at ICS 4 dextra; vesicular at ICS 4 sinistra; vesicular at ICS 6 dextra and sinistra
T3	Vesicular at ICS 2 dextra and sinistra; vesicular at ICS 4 dextra; wheezing at ICS 4 sinistra; vesicular at ICS 6 dextra and sinistra
T4	Wheezing at ICS 2 dextra; vesicular at ICS 2 sinistra; rhonchi at ICS 4 dextra; vesicular at ICS 4 sinistra; vesicular at ICS 6 dextra and sinistra
T5	Vesicular breath sounds at all examined points

The auscultation results show that abnormal breath sounds gradually decreased during the intervention period and were no longer found at the fifth session. The vital sign graph also shows changes across treatment sessions, with oxygen saturation tending to improve during the intervention period.

The trend of heart rate, oxygen saturation, and respiratory rate during the five sessions is shown in Figure 1.

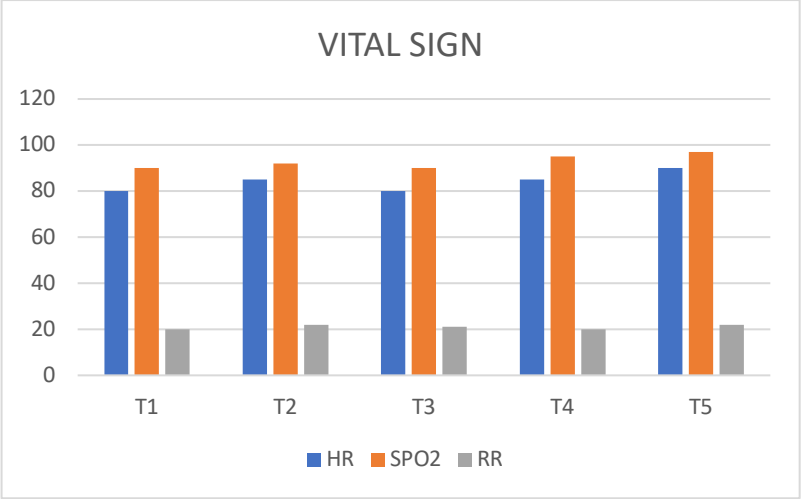

Figure 1. Changes in Vital Signs During Physiotherapy Sessions

Several patterns emerged from these findings. First, abnormal breath sounds such as wheezing and rhonchi were present at the beginning of treatment. Second, partial improvement was observed during the intermediate sessions, although abnormal sounds still appeared at certain lung fields. Third, all auscultation points showed vesicular breath sounds by the fifth session. Fourth, vital sign monitoring showed physiological changes across sessions, particularly an upward trend in oxygen saturation.

These findings suggest that the intervention was associated with improved airway condition and respiratory stability. The disappearance of wheezing and rhonchi at the final session indicates improvement in airway patency and reduction of abnormal respiratory sounds. The increase in oxygen saturation further supports the presence of improved oxygenation during treatment.

Changes in Dyspnea Severity Based on the Borg Scale and mMRC

The third finding concerns changes in dyspnea severity as assessed by the Borg Scale and the Modified Medical Research Council (mMRC) scale. Based on Figure 2, the Borg Scale score was 4 at T1 and T2, then decreased to 3 at T3, T4, and T5. Thus, after five physiotherapy sessions, the final Borg Scale score was 3, which indicates moderate dyspnea. In contrast, the mMRC score remained unchanged at 3 throughout the five sessions, indicating that the patient still experienced shortness of breath when walking about 100 meters or after walking for several minutes.

Visualisation of Data

Table 3. Borg Scale and mMRC Scores During Physiotherapy Sessions

Session	Borg Scale	mMRC
T1	4	3
T2	4	3
T3	3	3
T4	3	3
T5	3	3

The evaluation of dyspnea severity based on the Borg Scale and mMRC is presented in Figure 2.

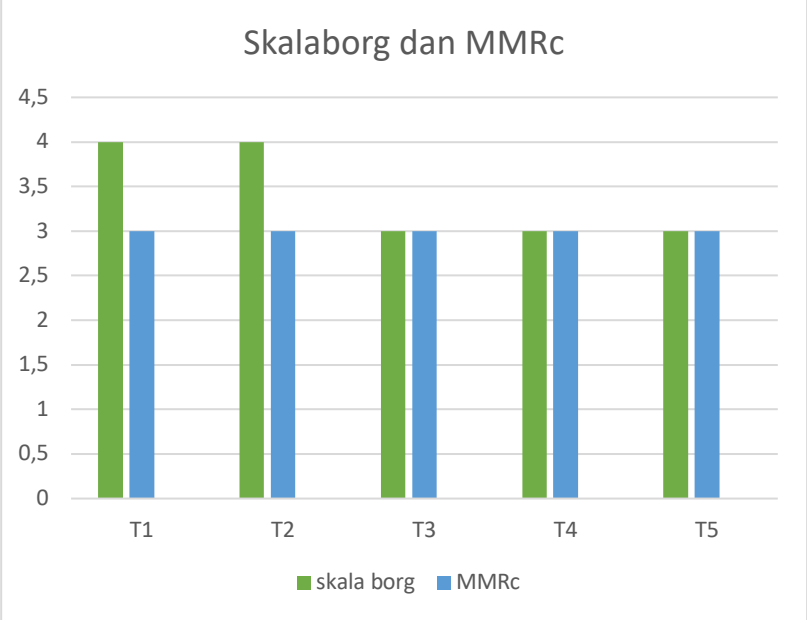

Figure 2. Borg Scale and mMRC Scores During Physiotherapy Sessions

The Borg Scale results show a decrease in perceived dyspnea after repeated intervention, while the mMRC score remained unchanged throughout the treatment sessions.

Several tendencies can be observed from these findings. First, the Borg Scale score decreased from 4 to 3 after the second session. Second, once the score decreased, it remained stable until the fifth session. Third, the final Borg Scale score still reflected moderate dyspnea. Fourth, the mMRC score did not change during the five treatment sessions, indicating persistent functional limitation.

These findings indicate that the intervention was associated with a reduction in the patient's subjective perception of dyspnea, as reflected by the Borg Scale. However, the

absence of change in the mMRC score suggests that functional limitations in daily activities had not improved within the short duration of the intervention. This may indicate that symptom relief occurred earlier than functional recovery.

DISCUSSION

The present study examined the effectiveness of a combination of respiratory physiotherapy interventions, including nebulizer therapy, myofascial release, pursed-lip breathing, deep breathing exercise, and thoracic expansion exercise, in a pediatric patient with bronchial asthma. The results showed improvements in several clinical indicators following five physiotherapy sessions. These improvements included increased thoracic expansion, increased peak expiratory flow values, normalization of breath sounds during auscultation, improved oxygen saturation, and a reduction in perceived dyspnea based on the Borg Scale. However, the mMRC score remained unchanged during the intervention period, indicating that functional limitations in daily activities were still present.

The improvement in respiratory condition observed in this study may be explained by the combined physiological effects of the administered interventions. Nebulizer therapy plays an important role in delivering medication directly into the respiratory tract in aerosol form, allowing the drug to reach the bronchial tree and alveoli more efficiently. This mechanism helps reduce bronchospasm, decrease airway inflammation, and improve airflow within the lungs. Previous studies have shown that nebulizer therapy with oxygen can improve breath sound patterns, increase oxygen saturation, reduce respiratory rate, and change abnormal breath sounds such as wheezing or rhonchi into normal vesicular sounds (Agus, 2018). Aerosol particles sized approximately 1–8 μm are capable of reaching deeper lung structures, including the alveoli, where immune defense cells are located, thus improving airway clearance and respiratory efficiency (Bosch et al., 2022; Idea et al., 2025). Additionally, nebulizer therapy can help dilute airway secretions, facilitate mucus clearance, and improve gas exchange, thereby reducing dyspnea symptoms in asthma patients (Rovsing et al., 2023).

Another important component of the intervention was myofascial release, which aims to reduce muscle tension and improve soft tissue mobility. In patients with bronchial asthma, accessory respiratory muscles such as the upper trapezius and sternocleidomastoid often experience excessive activation due to increased breathing effort during episodes of dyspnea. Prolonged muscle tension in these areas may limit thoracic expansion and increase

the work of breathing. The application of myofascial release techniques helps restore muscle elasticity, improve blood circulation, and enhance oxygen delivery to the affected tissues (Tongtako, 2024). As a result, respiratory muscle relaxation may reduce compensatory muscle activity and promote a more efficient breathing pattern. Previous studies also report that improving respiratory muscle flexibility can contribute to better ventilation and reduced respiratory discomfort in patients with chronic respiratory disorders (Fregonezi & Llurda-Almuzara, 2023; Zulkifli, 2022).

Breathing exercises also played a significant role in improving respiratory function in this case. Techniques such as pursed-lip breathing, deep breathing exercise, and thoracic expansion exercise help regulate breathing patterns and improve pulmonary ventilation. Pursed-lip breathing encourages prolonged exhalation, which helps maintain positive airway pressure, prevents airway collapse, and facilitates more efficient air expulsion from the lungs (Febriyanti & Herawati, 2026). Deep breathing exercise promotes alveolar expansion and improves oxygen diffusion by encouraging slow and controlled inhalation followed by controlled exhalation (Herawati, Hakim, et al., 2023). In addition, diaphragmatic breathing may help reduce respiratory effort and fatigue during physical activity by enhancing diaphragmatic function and increasing lung capacity (Rajab et al., 2025). Thoracic expansion exercises further enhance lung ventilation by encouraging deeper inhalation combined with brief breath holding, which allows air to reach poorly ventilated alveoli and improve overall lung compliance (Herawati, Hakim, et al., 2023).

When compared with previous studies, the findings of this case report are generally consistent with existing evidence regarding the benefits of respiratory physiotherapy in patients with asthma and other respiratory disorders. Previous studies have reported that breathing exercises and respiratory muscle training can improve pulmonary function, reduce dyspnea symptoms, and enhance respiratory efficiency. The improvement in thoracic expansion and peak expiratory flow observed in this study supports these findings. However, unlike some studies that report improvements in functional capacity, the mMRC score in this study remained unchanged. This difference may be related to the relatively short duration of the intervention, as functional improvement often requires a longer rehabilitation period.

From an interpretative perspective, the findings of this study highlight the importance of combining pharmacological and non-pharmacological approaches in asthma management. Physiotherapy interventions not only address airway obstruction but also target respiratory

muscle function and breathing mechanics. Improved chest wall mobility and breathing efficiency may help reduce respiratory effort and improve overall respiratory performance. These results suggest that respiratory physiotherapy can play a complementary role in comprehensive asthma management, particularly in pediatric patients who may benefit from non-invasive therapeutic strategies.

From a practical perspective, the findings of this study suggest several implications for clinical practice. The positive response observed in this case indicates that physiotherapy interventions may serve as an effective supportive therapy in pediatric asthma management. Healthcare providers, particularly physiotherapists and respiratory therapists, may consider incorporating structured breathing exercises and thoracic mobility techniques into asthma rehabilitation programs. However, it is important to acknowledge that this study was based on a single case, which limits the generalizability of the findings.

Finally, the results of this study indicate the need for further research involving larger sample sizes and longer intervention periods to better evaluate the long-term effects of respiratory physiotherapy in pediatric asthma patients. Future studies may also explore the integration of physiotherapy protocols into standard asthma management guidelines in order to optimize respiratory outcomes and improve quality of life for pediatric patients.

CONCLUSION

This case study shows that the application of respiratory physiotherapy interventions in a five-year-old child with bronchial asthma was associated with improvements in several respiratory indicators after five treatment sessions. The interventions, consisting of nebulizer therapy, myofascial release, pursed-lip breathing, deep breathing exercise, and thoracic expansion exercise, were followed by increased thoracic expansion, improved peak expiratory flow values, normalization of breath sounds from wheezing and rhonchi to vesicular sounds, and a reduction in perceived dyspnea based on the Borg Scale. These findings indicate that respiratory physiotherapy may contribute to improving respiratory mechanics and ventilation efficiency in pediatric patients with bronchial asthma.

The findings of this study provide practical clinical evidence regarding the potential role of respiratory physiotherapy as a complementary intervention in asthma management. By combining breathing exercises, chest mobility techniques, and nebulizer therapy, physiotherapy may help improve chest wall mobility, optimize breathing patterns, and enhance expiratory airflow capacity. This study contributes to the growing body of

knowledge supporting the integration of physiotherapy-based approaches into comprehensive asthma management, particularly in pediatric patients who may benefit from non-invasive therapeutic strategies.

However, this study has several limitations. The research was conducted as a single case report with a short intervention period, which limits the generalizability of the findings and prevents broader conclusions about long-term effectiveness. In addition, functional improvement based on the mMRC scale did not change during the intervention period, indicating that longer rehabilitation duration may be required to achieve functional recovery. Future studies involving larger sample sizes, longer treatment durations, and more comprehensive clinical measurements are recommended to further evaluate the effectiveness of respiratory physiotherapy interventions in pediatric asthma management.

REFERENCES

Agus. (2018). Efektivitas terapi nebulizer terhadap perbaikan pola napas pada pasien asma. *Jurnal Kesehatan Respirasi*.

Bosch, W. B. V. D., Kloosterman, S. F., Greidanus, R., Pijnenburg, M. W. H., Tiddens, H. A. W. M., & Janssens, H. M. (2022). Small airways targeted treatment with smart nebulizer technology could improve severe asthma in children: A retrospective analysis. *Journal of Asthma*, *59*(11), 2223-2233. https://doi.org/10.1080/02770903.2021.1996597

Dewi, A. F., Utami, M. N., & Perdana, S. S. (2023). Respiratory physiotherapy intervention in respiratory disorders. *Ahmar Metastasis Health Journal*, *3*(2), 77-86.

Dharmage, S. C., Perret, J. L., & Custovic, A. (2019). Epidemiology of asthma in children and adults. *Frontiers in Pediatrics*, *7*, 246. https://doi.org/10.3389/fped.2019.00246

Febriyanti, V. D., & Herawati, I. (2026). Effect of 4-7-8 breathing exercise on anxiety in university students: A quasi-experimental controlled study. *Journal of Health Research*, *14*(1), 91-95.

Fregonezi, G., & Llurda-Almuzara, L. (2023). Effect of respiratory muscle training in asthma: A systematic review and meta-analysis. *Annals of Physical and Rehabilitation Medicine*, *66*. https://doi.org/10.1016/j.rehab.2022.101691

Global Initiative for, A. (2024). *Global Strategy for Asthma Management and Prevention*. https://ginasthma.org

Herawati, I., Fitri, A., Ludin, M., Mutalazimah, M., Ishak, I., & Farah, N. M. F. (2023). Breathing exercise for hypertensive patients: A scoping review. *Frontiers in Physiology*. https://doi.org/10.3389/fphys.2023.1048338

Herawati, I., Hakim, M. L., Amalia, H., & Nurlita, A. (2023). Slow deep breathing exercise for respiratory improvement. *Journal of Community Health*, *3*(1), 9-16.

Idea, A., Anggraeni, K., Dewi, P., & Khoiriyati, A. (2025). The effectiveness of nebulizer therapy and pursed-lip breathing in the management of acute asthma: A case study. *Health Idea Journal*, *5*(3), 90-96.

Jayakumaran, J., Hunter, K., & Roy, S. (2020). Outpatient management of bronchial asthma: A comparative analysis between guideline-directed management and usual management. *Cureus*, *12*(6).

Koefoed, H. J. L., Zwitserloot, A. M., Vonk, J. M., & Koppelman, G. H. (2021). Asthma, bronchial hyperresponsiveness, allergy and lung function development until early adulthood: A systematic literature review. *Pediatric Allergy and Immunology*, *32*, 1238-1254. https://doi.org/10.1111/pai.13516

Martin, J., Townshend, J., & Brodlie, M. (2022). Diagnosis and management of asthma in children. *BMJ Paediatrics Open*. https://doi.org/10.1136/bmjpo-2021-001277

Rajab, M., Sudaryanto, W. T., & Lestari, R. E. (2025). Physiotherapy management using breathing exercise combination in patients with chronic pulmonary disease. *Indonesian Journal of Physiotherapy*.

Rovsing, A. H., Savran, O., & Ulrik, C. S. (2023). Nebulized therapy for acute severe asthma. *Frontiers in Allergy*. https://doi.org/10.3389/falgy.2023.1211949

Tongtako, W. (2024). Enhancing respiratory muscle strength and asthma control in children with asthma: The impact of balloon-breathing exercise. *PAAH*, *8*(1), 10-19. https://doi.org/10.5334/paah.321

World Health, O. (2024). *Asthma Fact Sheet*. https://www.who.int

Zulkifli. (2022). Pengaruh pursed lip breathing exercise terhadap saturasi oksigen, denyut nadi dan frekuensi pernapasan pada pasien asma bronkial. *Jurnal Kesehatan*, *10*(1), 203-210.