

MINI-REVIEW

Prevention and management of respiratory disease in cerebral palsy: Evidence-based strategies and future recommendations

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(humayra@ukm.edu.my)**Citation:** Tahayneh M, Jaber RJ, Karikalan B, Sulayman T, Humayra S. Prevention and management of respiratory disease in cerebral palsy: Evidence-based strategies and future recommendations. *Global Transl Med.* 2026;5(1):70-78.
doi: 10.36922/GTM025060014**Received:** February 5, 2025**Revised:** June 14, 2025**Accepted:** September 22, 2025**Published online:** February 3, 2026**Copyright:** © 2026 Author(s). This is an Open-Access article distributed under the terms of the Creative Commons Attribution License, permitting distribution, and reproduction in any medium, provided the original work is properly cited.**Publisher's Note:** AccScience Publishing remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.**Abstract**

Individuals with cerebral palsy (CP) are at an increased risk of developing respiratory diseases due to various factors, including motor impairments, postural abnormalities, and comorbidities, such as dysphagia and gastroesophageal reflux disease. This paper reviews evidence-based strategies and recommendations for the prevention and management of respiratory diseases in young adults with CP. It highlights the importance of early screening, vaccination, and infection control, as well as the role of pulmonary rehabilitation and physical therapy in improving respiratory function. Non-invasive ventilation and pharmacological management, including bronchodilators and mucolytics, are critical for individuals with compromised lung function. Multidisciplinary care, postural management, and swallowing therapy are key components of a comprehensive treatment approach. In addition, innovations in telemedicine and caregiver education are emerging as effective tools to enhance respiratory care and prevent complications. While challenges remain in accessibility and training, future directions, such as personalized medicine and rehabilitation technologies, offer promising solutions to further improve the respiratory health of individuals with CP. This review underscores the importance of early intervention, coordinated care, and ongoing support to optimize outcomes for individuals with CP and reduce the burden of respiratory diseases.

Keywords: Cerebral palsy; Clinical outcomes; Neurological disorder; Non-invasive ventilation; Respiratory disease

1. Introduction

Cerebral palsy (CP) is a group of neurological disorders resulting from non-progressive brain injury or malformation that occurs during early brain development. It is characterized by varying degrees of motor dysfunction, often accompanied by intellectual disabilities, sensory impairments, and musculoskeletal abnormalities. CP is one of the most common childhood disabilities.¹ Population-based data indicate that the estimated prevalence of CP ranges from 1 to almost 4/1,000 live births or children,² accounting for 8.1 million cases globally.³ In addition, CP contributes to approximately 6.5% of all years lived with disability from adverse health conditions in children under 5 years.³ As individuals with CP live into adulthood, they face numerous health challenges, and respiratory diseases have become a leading cause of morbidity and mortality within this population.⁴ Respiratory complications in CP are often underappreciated in terms of their impact on both quality of life and life expectancy. This review aims to explore the prevention and management of respiratory diseases in young adults with CP, focusing on evidence-based strategies that can enhance health outcomes.

The respiratory complications in individuals with CP are multifactorial, arising from a combination of impaired muscle control, structural abnormalities, and neurological dysfunction. Muscular weakness is a hallmark feature of CP and significantly impairs respiratory muscle function.⁵ Weakness in the diaphragm, intercostal muscles, and other muscles responsible for respiration weakens the ability to expel secretions from the airways, thereby increasing the risk of pneumonia.⁶ The chronic inability to cough effectively and expel airway secretions can lead to the development of bronchiectasis, especially in individuals with CP. Bronchiectasis in CP is a serious but often overlooked consequence of chronic airway clearance dysfunction and recurrent aspiration, which necessitates early screening and intervention to improve respiratory outcomes.⁷ Additionally, limited mobility and poor postural control, which are common in individuals with CP, contribute to ineffective ventilation and increased pulmonary congestion.⁸ The combination of these impairments predisposes individuals to chronic respiratory conditions, such as recurrent chest infections, aspiration pneumonia, and respiratory failure.⁴

Individuals with CP may also suffer from structural abnormalities, such as scoliosis, which can further exacerbate respiratory issues.⁹ Scoliosis alters the shape of the thoracic cavity, restricting lung expansion and reducing respiratory efficiency. This mechanical disadvantage is compounded by impaired cough reflexes, which are crucial for clearing mucus from the lungs and preventing

infections.¹⁰ Patients with CP, specifically those with severe impairments, tracheostomies, or chronic ventilation, are at higher risk of colonization with multidrug-resistant Gram-negative bacteria, notably *Pseudomonas aeruginosa*.¹¹ The respiratory vulnerabilities make individuals with CP particularly susceptible to a range of respiratory diseases, including asthma and obstructive sleep apnea.¹²

In addition to the physical health concerns, respiratory diseases in individuals with CP significantly impact their psychosocial well-being. Respiratory complications often limit physical activity, leading to a cycle of immobility and further muscle deconditioning.¹³ This can hinder participation in social, educational, and recreational activities, negatively affecting the individual's quality of life. Frequent hospitalizations due to respiratory infections place an additional strain on families and caregivers, both emotionally and financially.¹⁴ Furthermore, respiratory complications contribute to pre-mature mortality in individuals with CP, with respiratory failure cited as one of the most common causes of death in this population.⁴

Effective prevention and management strategies are essential to address the high burden of respiratory disease in individuals with CP. Early detection and intervention are critical to minimizing the risk of respiratory complications and improving long-term outcomes. Multidisciplinary care that includes respiratory therapy, physical therapy, and pharmacologic management has been shown to reduce the incidence of respiratory infections and improve pulmonary function.⁶ Postural drainage techniques, respiratory muscle training, and mechanical ventilation have been explored as potential interventions for improving respiratory function in individuals with CP.¹³ Pharmacological treatments, such as bronchodilators and mucolytics, can also play a role in managing airway clearance and reducing the frequency of respiratory exacerbations.^{4,13}

Despite these advancements, much of the literature on respiratory management in CP is based on clinical observations and expert opinions, with limited high-quality, large-scale studies.¹⁰ This highlights the need for robust evidence to identify the most effective strategies tailored to the diverse needs of individuals with CP. It is also essential to consider broader healthcare system implications, as healthcare providers must be equipped with the knowledge and tools to address the complex respiratory issues faced by individuals with CP. Our review examines the current evidence surrounding the prevention and management of respiratory diseases in individuals with CP. By analyzing both individual and systemic approaches, we seek to provide evidence-based recommendations to enhance respiratory health outcomes and improve the quality of life for individuals with CP.

1.1. Epidemiology of respiratory disease in CP

Young individuals with CP are at higher risk of developing respiratory diseases compared to their peers. Studies have shown that approximately 50–70% of individuals with CP experience chronic respiratory problems, with frequent hospitalizations due to respiratory infections, aspiration pneumonia, and respiratory failure.^{4,10} Current literature exhibits gender bias, with CP frequently diagnosed in males, who also present with severe motor and health complications.¹⁵ Black infants in the USA have a 29% higher CP risk than White infants, and Māori individuals in New Zealand with CP face significantly higher rates of respiratory-related hospitalization.¹⁶ Finally, age-based gaps persist, as research predominantly focuses on children, overlooking adults with CP who may experience elevated respiratory morbidity.¹⁶ The incidence of respiratory diseases increases as individuals with CP age, and the risk is further exacerbated by the severity of the motor impairment and the degree of cognitive involvement.⁸

Recent data also highlight that respiratory complications are one of the primary contributors to pre-mature mortality in individuals with CP, particularly those with severe conditions.¹⁷ Respiratory issues are often overlooked during the transition from pediatric to adult care, resulting in delayed interventions and suboptimal management.¹⁷

1.2. Respiratory impairment in CP

The pathophysiology of respiratory impairment in CP is multifactorial. Respiratory muscle weakness, particularly in the diaphragm and intercostal muscles, significantly reduces the ability to clear mucus from the lungs. This predisposes individuals to chronic respiratory infections and atelectasis.¹⁸ Additionally, numerous individuals with CP suffer from scoliosis, which restricts lung expansion and ventilation.⁹ Gastroesophageal reflux disease (GERD) is also common in this population, leading to aspiration and recurrent respiratory infections.¹⁹ Furthermore, impaired swallowing and ineffective cough reflexes can result in aspiration of food or liquids into the airway, leading to aspiration pneumonia.¹⁹ The complex nature of these respiratory impairments requires comprehensive, individualized care strategies to prevent and manage respiratory disease.

1.3. Risk factors for respiratory diseases in CP

Individuals with CP face a heightened risk of respiratory diseases due to several interrelated factors that affect their respiratory function (Figure 1). The risk factors for respiratory disease in individuals with CP are multifaceted,

involving motor, cognitive, anatomical, and comorbid conditions.²⁰ Understanding these risk factors is crucial for developing comprehensive care plans that address the unique respiratory needs of individuals with CP and reduce the incidence of respiratory complications.

1.3.1. Motor impairment

One of the primary risk factors is motor impairment, which directly impacts respiratory muscle strength and coordination. Individuals with severe forms of CP, such as quadriplegia, often experience weakness in the diaphragm and other respiratory muscles, making it difficult to clear mucus from the lungs effectively.²¹ This impaired ability to clear secretions increases the susceptibility to respiratory infections, atelectasis, and chronic lung disease.¹¹ The severity of motor impairment correlates with an increased risk of respiratory complications, and this risk is pronounced in individuals who also experience cognitive impairments that hinder their ability to recognize or communicate respiratory distress.²²

1.3.2. Impaired swallowing and aspiration

This is another significant risk factor for respiratory diseases associated with CP. Numerous individuals with CP experience dysphagia, or difficulty swallowing, increasing the likelihood of food or liquid being aspirated into the airway.¹⁹ Aspiration can lead to aspiration pneumonia, a serious respiratory condition that often requires hospitalization and prolonged treatment. Additionally, the compromised airway clearance mechanisms in these individuals further complicate respiratory health.¹⁷ Swallowing difficulties often require interventions, such as speech therapy or modifications in feeding techniques, to reduce the risk of aspiration.¹⁹ Gastrostomy feeding in CP patients with chronic dysphagia improves nutritional status and can reduce aspiration during oral intake, but respiratory infections remain common due to ongoing aspiration of saliva or reflux. These individuals require comprehensive airway management and reflux control alongside enteral feeding to reduce morbidity.²³

1.3.3. Postural abnormalities

Postural abnormalities, such as scoliosis, are another critical risk factor for respiratory disease in CP. Many individuals with CP develop scoliosis, which can lead to restricted lung expansion and reduced ventilation.⁹ The curvature of the spine restricts the capacity of the lungs to fully expand, impairing the ability to breathe deeply and effectively. This can lead to hypoventilation, reduced oxygen levels, and chronic respiratory problems. The severity of scoliosis often correlates with the degree of respiratory dysfunction, and individuals with severe postural deformities often

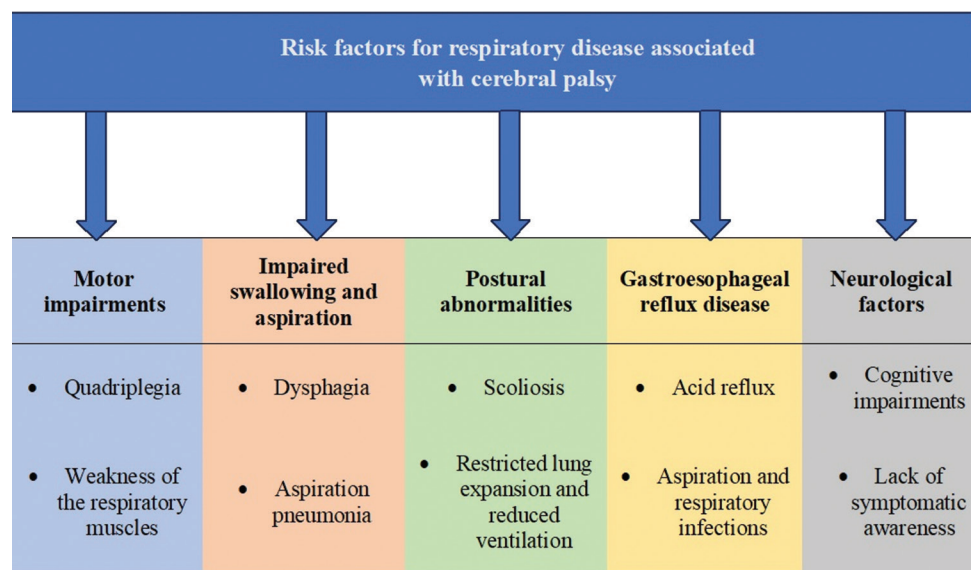


Figure 1. Schematic presentation of risk factors of respiratory disease associated with cerebral palsy. Image created by the authors.

require interventions, such as mechanical ventilation or surgical correction.^{18,23}

1.3.4. GERD

GERD is another common comorbidity associated with CP that significantly increases the risk of respiratory complications. GERD can cause stomach contents to reflux into the esophagus and, in some cases, into the airway, leading to aspiration and respiratory infections.¹⁹ The constant irritation and inflammation of the airway from acid reflux can lead to several conditions, such as asthma, chronic cough, or aspiration pneumonia, further complicating respiratory care.

1.3.5. Neurological factors

Cognitive impairments and lack of awareness contribute to the increased vulnerability to respiratory disease in individuals with CP. Most of them may not have the cognitive ability to recognize symptoms of respiratory distress, such as difficulty breathing or coughing, delaying timely medical intervention.^{22,24} The inability to effectively communicate discomfort or respiratory symptoms can make it challenging for caregivers to provide appropriate care, leading to delayed responses to respiratory crises.

2. Evidence-based prevention strategies

2.1. Early screening and diagnosis

Early detection of respiratory dysfunction is crucial in preventing long-term complications. Regular screening for respiratory conditions, including pulmonary function tests and imaging studies, should be conducted to assess lung health and detect early signs of respiratory

impairment.¹¹ Pulmonary function testing can help identify early abnormalities in lung function, enabling timely interventions.²⁵

2.2. Vaccination and immunization

Vaccination plays a pivotal role in preventing respiratory infections in individuals with CP. Immunizations against influenza, pneumococcus, and other respiratory pathogens should be prioritized because individuals with CP are more vulnerable to severe outcomes from respiratory infections.²⁶ Therefore, ensuring that they are up-to-date on all recommended vaccinations is an essential preventive measure.¹⁷

2.3. Respiratory hygiene and infection control

Respiratory hygiene, including handwashing, mask use during illness, and avoidance of environmental pollutants, can reduce the risk of respiratory infections.²⁷ In care settings, strict infection control protocols are necessary to prevent cross-contamination and respiratory illness outbreaks.^{17,28}

3. Management of respiratory disease: Therapeutic approaches

3.1. Pulmonary rehabilitation and physical therapy

Physical therapy aimed at strengthening respiratory muscles can improve lung function and overall respiratory health in individuals with CP. Regular exercise, including aerobic activities and chest physiotherapy, helps enhance lung capacity, improve mucus clearance, and reduce infection risks.²⁹ Breathing exercises, such as diaphragmatic and pursed-lip breathing, can also promote better ventilation.³⁰

3.2. Non-invasive ventilation (NIV) and respiratory support

For individuals with significant respiratory compromise, NIV, such as bilevel positive airway pressure or continuous positive airway pressure, can improve oxygenation and reduce the work of breathing.³¹ These devices help to maintain open airways and support breathing, particularly during sleep. NIV is effective in reducing the risk of respiratory failure and improving the quality of life for individuals with severe respiratory symptoms.³¹ However, in individuals who develop severe chronic ventilatory insufficiency, invasive mechanical ventilation via tracheostomy is often required to maintain adequate respiratory function and manage airway secretions.³² While tracheostomy can reduce upper airway obstruction and enhance secretion clearance, it significantly increases the risk of respiratory infections, particularly ventilator-associated pneumonia, due to frequent colonization by multidrug-resistant organisms.¹¹

3.3. Pharmacological management

Pharmacological interventions, including bronchodilators, corticosteroids, and mucolytics, can be used to manage underlying respiratory conditions. Bronchodilators help open the airways, while corticosteroids can reduce lung inflammation.^{8,28} Mucolytics aid in the clearance of thick mucus, making coughing easier and reducing the risk of infections.³³ Medications should be prescribed based on the individual's specific needs and the severity of respiratory disease.³³

3.4. Therapeutic effect of magnetic nanomaterials

Magnetic nanoparticles have currently emerged as a promising tool in the treatment of pulmonary respiratory malignancies (such as lung cancer) due to their unique magnetic properties, biocompatibility, and ability to be functionalized for targeted therapy.³⁴ A recent study demonstrated that magnesium-doped ironoxide nanoparticles in combination with an alternating magnetic field can produce effective localized hyperthermia, significantly inhibiting lung tumor growth *in vivo*, while the broader literature supports their role in precision drug delivery, imaging, and combating drug resistance.³⁵ Another study showed that inhalable magnetite (iron [II, III] oxide)/poly-lactic-co-glycolic acid magnetic nanocomposite microparticles offered a powerful platform for targeted pulmonary delivery of cancer therapeutics, with strong safety, localization, and multi-modal capacity.³⁶

3.5. Multidisciplinary approach in CP patients' respiratory care

Managing respiratory disease in patients with CP requires a multidisciplinary approach, involving

healthcare professionals from various specialties, including pulmonology, physical therapy, speech therapy, nutrition, and nursing.³⁷ A coordinated care plan ensures comprehensive treatment, addressing the physical, nutritional, and psychological aspects of care. The involvement of a speech therapist is critical to address swallowing issues, while physical therapists can provide interventions to improve posture and respiratory muscle function.^{30,37}

4. Challenges in implementing evidence-based strategies

While significant studies have been conducted in the prevention and management of respiratory disease in individuals with CP, several challenges persist in providing optimal care. One of the primary challenges is the lack of awareness and specialized training among healthcare providers to recognize and manage respiratory issues specific to individuals with CP. The transition from pediatric to adult care often leads to gaps in care due to the under-recognition of respiratory problems in this population, particularly in those with milder forms of CP who may not exhibit obvious signs of respiratory distress.²⁴ As a result, respiratory dysfunction may be undiagnosed or untreated, leading to severe complications.⁸

Another significant barrier is the limited access to specialized care, especially in rural or low-resource settings. Numerous individuals with CP face challenges in accessing high-quality respiratory therapies, such as pulmonary rehabilitation and NIV, due to cost, geographic location, or a lack of healthcare infrastructure.³⁸ In addition, the financial burden of advanced treatments, including NIV and chest physiotherapy, can be prohibitive for low-income families, limiting the availability of these interventions.³⁹

Moreover, caregivers often lack sufficient training to manage the complex needs of individuals with CP, especially those with advanced respiratory diseases. Proper caregiver education and support are critical for the successful implementation of respiratory interventions at home.^{17,40} Without adequate training, caregivers may struggle to perform daily respiratory exercises, monitor for signs of respiratory distress, or use ventilatory support devices effectively.⁴⁰

5. Future directions in respiratory care for CP patients

Research in respiratory care for individuals with CP continues to evolve, with promising innovations on the horizon. Future directions include the use of telemedicine, which can improve access to care, enabling remote monitoring and consultations.^{20,41} Advances in

Table 1. Key evidence-based strategies for managing respiratory diseases in cerebral palsy

Strategy/recommendation	Description	Outcome
Early screening and diagnosis	Regular screening for respiratory issues through pulmonary function tests and imaging studies	Early detection can prevent complications, allowing for timely interventions
Vaccination and immunization	Ensure up-to-date immunizations for influenza, pneumococcus, and other respiratory pathogens	Vaccination significantly reduces the risk of respiratory infections
Respiratory hygiene and infection control	Promote handwashing, mask-use during illness, and infection control measures in care settings	Helps prevent the spread of respiratory infections
Pulmonary rehabilitation and physical therapy	Implement physical therapy to strengthen respiratory muscles and improve lung capacity	Regular exercise improves lung function and reduces infection rates
NIV	Use devices such as BiPAP or CPAP for individuals with significant respiratory compromise to improve oxygenation	NIV is effective in preventing respiratory failure and improving the quality of life
Pharmacological management	Use bronchodilators, corticosteroids, and mucolytics to manage airway obstruction, inflammation, and mucus clearance	Medications reduce respiratory symptoms and improve lung function
Swallowing therapy	Provide speech therapy to address dysphagia and reduce the risk of aspiration	Reduces the risk of aspiration pneumonia
Multidisciplinary approach	Involve healthcare providers from various specialties, including pulmonologists, therapists, and nutritionists	A coordinated team approach improves overall management and outcomes
Postural management	Address postural abnormalities (e.g., scoliosis) with physical therapy, bracing, or surgery	Correcting postural deformities can improve lung function and reduce respiratory complications
Telemedicine and remote monitoring	Use telemedicine for remote consultations and monitoring of respiratory function	Telemedicine enhances accessibility to care, especially in rural areas
Early and ongoing caregiver training	Educate caregivers on proper respiratory care techniques and signs of distress	Caregiver education reduces the likelihood of complications and improves outcomes

Abbreviations: BiPAP: Bilevel positive airway pressure; CPAP: Continuous positive airway pressure; NIV: Non-invasive ventilation.

genomics and personalized medicine may provide more targeted therapies for respiratory diseases in CP.^{28,42} The development of effective rehabilitation tools and technology, such as wearable devices for respiratory monitoring, could enhance the management of respiratory disease in CP patients.⁴³ In addition, advances in artificial intelligence can help shape future research directions and rehabilitation approaches, enhancing the functional outcomes in CP.⁴⁴ In summary, future research should focus on developing individualized airway clearance strategies and using mobile health technologies to monitor patient status, facilitating prompt intervention in cases of respiratory illness. [Table 1](#) highlights the key evidence-based strategies for the prevention and management of respiratory diseases in CP.

6. Conclusion

Individuals with CP are at significant risk for respiratory diseases, and evidence-based prevention and management strategies are essential to optimizing their health outcomes. Early intervention, regular monitoring, and a multidisciplinary approach can significantly reduce the burden of respiratory disease, improving quality of life and longevity. With continued research and a focus on individualized care, young individuals with CP can achieve

better respiratory health and quality of life. High-volume, multi-centric studies are crucial in CP research as they can enhance the generalizability of findings, improve statistical power, and reduce the risk of bias. By capturing diverse patient populations and healthcare settings, empirical studies are needed to evaluate interventions and facilitate evidence-based care in effective CP management.

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Conflict of interest

The authors declare they have no competing interests.

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Consent for publication

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References

- Rosenbaum P, Paneth N, Leviton A, *et al.* A report: The definition and classification of cerebral palsy. *Dev Med Child Neurol.* 2007;49(3):8-14.
doi: 10.1111/j.1469-8749.2007.00001.x
- Centers for Disease Control and Prevention. *Data and Statistics for Cerebral Palsy*; 2022. Available from: https://archive.cdc.gov/www_cdc_gov/ncbddd/cp/data.html [Last accessed on 2025 Jun 10].
- Olusanya BO, Gladstone M, Wright SM, *et al.* Cerebral palsy and developmental intellectual disability in children younger than 5 years: Findings from the GBD-WHO rehabilitation database 2019. *Front Public Health.* 2022;10:894546.
doi: 10.3389/fpubh.2022.894546
- Boel L, Pernet K, Toussaint M, *et al.* Respiratory morbidity in children with cerebral palsy: An overview. *Dev Med Child Neurol.* 2019;61(6):646-653.
doi: 10.1111/dmcn.14060
- Givon U. Beyin felcinde kas zayıflığı. [Muscle weakness in cerebral palsy]. *Acta Orthop Traumatol Turc.* 2009;43(2):87-93.
doi: 10.3944/aott.2009.087
- Spoto G, Accetta AS, Grella M, Di Modica I, Nicotera AG, Di Rosa G. Respiratory comorbidities and complications of cerebral palsy. *Dev Neurorehabil.* 2024;27(5-6):194-203.
doi: 10.1080/17518423.2024.2374959
- Yoon SY, Kim YW, Choi JY. Pulmonary rehabilitation in a patient with bronchiectasis and underlying cerebral palsy: A case presentation. *PM R.* 2018;10(5):548-551.
doi: 10.1016/j.pmrj.2017.09.009
- Marpole R, Blackmore AM, Gibson N, Cooper MS, Langdon K, Wilson AC. Evaluation and management of respiratory illness in children with cerebral palsy. *Front Pediatr.* 2020;8:333.
doi: 10.3389/fped.2020.00333
- Cloake T, Gardner A. The management of scoliosis in children with cerebral palsy: A review. *J Spine Surg.* 2016;2(4):299-309.
doi: 10.21037/jss.2016.09.05
- Kürtül Çakar M, Cinel G. The respiratory problems of patients with cerebral palsy requiring hospitalization: Reasons and solutions. *Pediatr Pulmonol.* 2021;56(6):1626-1634.
doi: 10.1002/ppul.25306
- Fainardi V, Rizzo L, Zambelli G, *et al.* Airway colonization in children with medical complexity: Challenges and management strategies. *J Clin Med.* 2025;14(3):848.
doi: 10.3390/jcm14030848
- Dias BLS, De Lima FM. Respiratory system impairments in children with cerebral palsy: Outpatient surveillance, diagnosis, and treatment. *Med Res Arch.* 2021;9(11).
doi: 10.18103/mra.v9i11.2594
- El Banna EH, El Hadidy EI, Ali WM. Effect of respiratory therapy on pulmonary functions in children with cerebral palsy: A systematic review. *Bull Fac Phys Ther.* 2020;25(1):18.
doi: 10.1186/s43161-020-00016-6
- Guyard A, Fauconnier J, Mermet MA, Cans C. Impact on parents of cerebral palsy in children: A literature review. *Arch Pediatr.* 2011;18(2):204-214.
doi: 10.1016/j.arcped.2010.11.008
- Romeo DM, Venezia I, Pede E, Brogna C. Cerebral palsy and sex differences in children: A narrative review of the literature. *J Neurosci Res.* 2023;101(5):783-795.
doi: 10.1002/jnr.25020
- Sorhage A, Keenan S, Chong J, *et al.* Respiratory health inequities among children and young adults with cerebral palsy in aotearoa New Zealand: A data linkage study. *J Clin Med.* 2022;11(23):6968.
doi: 10.3390/jcm11236968
- Gibson N, Blackmore AM, Chang AB, *et al.* Prevention and management of respiratory disease in young people with cerebral palsy: Consensus statement. *Dev Med Child Neurol.* 2021;63(2):172-182.
doi: 10.1111/dmcn.14640
- Grychtol R, Chan EY. Use of non-invasive ventilation in cerebral palsy. *Arch Dis Child.* 2018;103(12):1170-1177.
doi: 10.1136/archdischild-2017-313959
- Calderone A, Militi D, Cardile D, Corallo F, Calabrò RS, Militi A. Swallowing disorders in cerebral palsy: A systematic review of oropharyngeal Dysphagia, nutritional impact, and health risks. *Ital J Pediatr.* 2025;51(1):57.
doi: 10.1186/s13052-025-01903-1
- Ambrosino N, Fracchia C. The role of tele-medicine in

- patients with respiratory diseases. *Expert Rev Respir Med*. 2017;11(11):893-900.
doi: 10.1080/17476348.2017.1383898
21. Bax M, Tydeman C, Flodmark O. Clinical and MRI correlates of cerebral palsy: The European cerebral palsy study. *JAMA*. 2006;296(13):1602-1608.
doi: 10.1001/jama.296.13.1602
 22. Brandenburg JE, Fogarty MJ, Sieck GC. Why individuals with cerebral palsy are at higher risk for respiratory complications from COVID-19. *J Pediatr Rehabil Med*. 2020;13(3):317-327.
doi: 10.3233/prm-200746
 23. Shiver AL, Shaw KA, Murphy JS, Fletcher ND. Gastrostomy tubes in children with nonambulatory cerebral palsy and neuromuscular scoliosis: An enemy or an ally? *J Pediatr Orthop Soc North Am*. 2021;3(3):259.
doi: 10.55275/jposna-2021-259
 24. Peneva P, Pancheva R, Nikolova SP. Unveiling respiratory challenges in cerebral palsy: A comprehensive review. *Biomed Rev*. 2023;34:121-132.
doi: 10.14748/bmr.v34.9620
 25. Desai B, Lesser DJ, Sunwoo BY. Managing pulmonary complications in adults with cerebral palsy: A vulnerable transition. *CHEST Pulm*. 2023;1(3):100025.
doi: 10.1016/j.chpulm.2023.100025
 26. Micheletto C, Aliberti S, Andreoni M, *et al*. Vaccination strategies in respiratory diseases: Recommendation from AIPO-ITS/ETS, SIMIT, SIP/IRS, and SItI. *Respiration*. 2025;104(8):556-574.
doi: 10.1159/000544919
 27. Greenhalgh T, MacIntyre CR, Baker MG, *et al*. Masks and respirators for prevention of respiratory infections: A state of the science review. *Clin Microbiol Rev*. 2024;37(2):e00124-e00123.
doi: 10.1128/cmr.00124-23
 28. Myers LL, Nerminathan A, Fitzgerald DA, *et al*. Transition to adult care for young people with cerebral palsy. *Paediatr Respir Rev*. 2020;33:16-23.
doi: 10.1016/j.prrv.2019.12.002
 29. Keles MN, Elbasan B, Apaydin U, Aribas Z, Bakirtas A, Kokturk N. Effects of inspiratory muscle training in children with cerebral palsy: A randomized controlled trial. *Braz J Phys Ther*. 2018;22(6):493-501.
doi: 10.1016/j.bjpt.2018.03.010
 30. Alhumaid MM, Asiri FYI, Said MA, Haegle JA. The efficacy of physical activity or exercise among individuals with cerebral palsy: An umbrella review of systematic reviews. *Complement Ther Med*. 2025;93:103228.
doi: 10.1016/j.ctim.2025.103228
 31. Rezoagli E, Nova A, Carteaux G, *et al*. A clinical guide to non-invasive respiratory support in acute respiratory failure: Ventilation settings, technical optimization and clinical indications. *Crit Care*. 2025;29(1):496.
doi: 10.1186/s13054-025-05730-y
 32. Lam KF, Lam P. Tracheostomy in children with severe neurological impairment: A single-centre review. *J Paediatr Respirol Crit Care*. 2015;11:4-11.
 33. Hocquigny A, Hugerot H, Ghanem R, *et al*. Mucoactive drugs and multiple applications in pulmonary disease therapy. *Eur J Pharm Biopharm*. 2024;194:110-117.
doi: 10.1016/j.ejpb.2023.12.001
 34. El-Sherbiny IM, Elbaz NM, Sedki M, Elgammal A, Yacoub MH. Magnetic nanoparticles-based drug and gene delivery systems for the treatment of pulmonary diseases. *Nanomedicine (Lond)*. 2017;12(4):387-402.
doi: 10.2217/nnm-2016-0341
 35. Winkler R, Ciria M, Ahmad M, Plank H, Marcuello C. A review of the current state of magnetic force microscopy to unravel the magnetic properties of nanomaterials applied in biological systems and future directions for quantum technologies. *Nanomaterials (Basel)*. 2023;13(18):2585.
doi: 10.3390/nano13182585
 36. Stocke NA, Meenach SA, Arnold SM, Mansour HM, Hilt JZ. Formulation and characterization of inhalable magnetic nanocomposite microparticles (MnMs) for targeted pulmonary delivery via spray drying. *Int J Pharm*. 2015;479(2):320-328.
doi: 10.1016/j.ijpharm.2014.12.050
 37. Blackmore AM, Gibson N, Cooper MS, Langdon K, Moshovis L, Wilson AC. Interventions for management of respiratory disease in young people with cerebral palsy: A systematic review. *Child Care Health Dev*. 2019;45(5):754-771.
doi: 10.1111/cch.12703
 38. Oguntade HA, Nishath T, Owusu PG, Papadimitriou C, Sakyi KS. Barriers to providing healthcare to children living with cerebral palsy in Ghana: A qualitative study of healthcare provider. *PLOS Glob Public Health*. 2022;2(12):e0001331.
doi: 10.1371/journal.pgph.0001331
 39. Twagirumugabe T, Gashame DF, Uwamahoro DL, Riviello E. Advanced non-invasive respiratory support in resource-constrained settings: A narrative review. *Crit Care*. 2025;29(1):492.
doi: 10.1186/s13054-025-05688-x

-
40. Rachamose N, Harvey C. The barriers to caring for a child living with cerebral palsy (CP) in rural Limpopo, South Africa. *Disabilities*. 2025;5(1):11-18.
doi: 10.3390/disabilities5010011
41. Ben-Pazi H, Beni-Adani L, Lamdan R. Accelerating telemedicine for cerebral palsy during the COVID-19 pandemic and beyond. *Front Neurol*. 2020;11:746.
doi: 10.3389/fneur.2020.00746
42. Coller RJ, Singh-Verdefflor K, Eickhoff J, *et al*. Preventing respiratory illness in cerebral palsy: Results of a pilot randomized controlled trial. *PLoS One*. 2025; 20(6):e0325970.
doi: 10.1371/journal.pone.0325970
43. Vitazkova D, Foltan E, Kosnacova H, *et al*. Advances in respiratory monitoring: A comprehensive review of wearable and remote technologies. *Biosensors (Basel)*. 2024; 14(2):90.
doi: 10.3390/bios14020090
44. Paul S, Nahar A, Bhagawati M, Kunwar AJ. A review on recent advances of cerebral palsy. *Oxid Med Cell Longev*. 2022;2022(1):2622310.
doi: 10.1155/2022/2622310