

Gross Motor Function and Recurrent Pneumonia-Related Hospitalization in Children with Cerebral Palsy

Nurul Azmi¹⁾, Fadhilah Tia Nur¹⁾, Agustina Wulandari¹⁾

¹⁾Department of Child Health, Faculty of Medicine, Universitas Sebelas Maret, Surakarta, Indonesia

Received: June 09, 2026; Accepted: August 20, 2026; Available online: September 16, 2026

ABSTRACT

Background: Cerebral palsy (CP) is commonly complicated by respiratory disease, and pneumonia is a major cause of hospitalization and mortality. The contribution of gross motor impairment to recurrent pneumonia-related hospitalization remains uncertain. This study aimed to determine the association between gross motor function and recurrent pneumonia-related hospitalization in children with CP.

Subjects and Method: This cross-sectional study was conducted at the Pediatric Neurology Out-patient Clinic of Dr. Moewardi Regional General Hospital, Surakarta, Indonesia, from May to July 2025. Seventy-seven children aged 1-18 years with CP and a history of pneumonia-related hospitalization were recruited by consecutive sampling. Gross motor function was classified using the Gross Motor Function Classification System (GMFCS). Recurrent pneumonia-related hospitalization was the dependent variable. Bivariate analysis used Chi-square or Fisher exact tests, followed by multivariable binary logistic regression.

Results: Gross motor function and gastrointestinal disorders levels III-V was associated with recurrent pneumonia-related hospitalization in children with cerebral palsy (OR= 4.50; 95% CI= 1.01 to 20.09; p= 0.049).

Conclusion: More severe gross motor impairment (GMFCS III-V) is associated with recurrent pneumonia-related hospitalization in children with cerebral palsy. GMFCS may help identify children who require closer respiratory monitoring.

Keywords: cerebral palsy, gross motor impairment, pneumonia, hospitalization

Correspondence:

Fadhilah Tia Nur. Department of Child Health, Faculty of Medicine, Universitas Sebelas Maret, Dr. Moewardi Regional General Hospital, Jl. Kolonel Sutarto No. 132, Surakarta, Central Java 57126, Indonesia. Email: fadhilahtia@staff.uns.ac.id.

Cite this as:

Azmi N, Nur FT, Wulandari A (2026). Gross Motor Function and Recurrent Pneumonia-Related Hospitalization in Children with Cerebral Palsy. *J Matern Child Health*. 11(5): 315-325. <https://doi.org/10.26911/thejmch.2026.11.05.02>.



© Nurul Azmi. Published by Master's Program of Public Health, Universitas Sebelas Maret, Surakarta. This open-access article is distributed under the terms of the [Creative Commons Attribution 4.0 International \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/). Re-use is permitted for any purpose, provided attribution is given to the author and the source is cited.

BACKGROUND

Cerebral palsy (CP) is a group of permanent disorders of movement and posture that cause activity limitations in children. The prevalence of CP is estimated at approximately 2–3 cases per 1,000 live births ([Hallman-Cooper and Cabrero, 2024](#)). Children with CP frequently experience

multisystem complications that can affect their daily activities, quality of life, and long-term health outcomes.

Respiratory complications are among the most important health problems in children with CP. Approximately half of individuals with CP may experience

respiratory complications, and respiratory disease is a major cause of morbidity and mortality in this population ([Blackmore et al., 2016b](#)). Children with CP are particularly vulnerable to respiratory tract infections and may require hospitalization because of the severity of these complications ([Kuo et al., 2020](#)). Pneumonia is an important cause of hospitalization and is also a major cause of death among individuals with CP ([Blair et al., 2019](#)).

Pneumonia-related morbidity in children with CP may be related to several mechanisms. Motor impairment can affect respiratory muscle function, cough effectiveness, and the ability to clear airway secretions. Difficulties with swallowing and gastrointestinal function may also contribute to aspiration and respiratory infections. In Indonesia, aspiration pneumonia has been reported in approximately 19% of children with CP ([Hafifah et al., 2018](#)). These factors may interact and contribute to recurrent respiratory problems and repeated hospitalization.

Several clinical characteristics have been associated with respiratory complications in children with CP. These include impaired gross motor function, gastrointestinal disorders, airway abnormalities, malnutrition, and epilepsy ([Blackmore et al., 2018](#); [Blackmore et al., 2020](#)). Children with more severe motor impairment may have greater functional limitations and may also have other clinical problems that contribute to respiratory morbidity. However, the relationship between gross motor function and pneumonia-related hospitalization may be influenced by these coexisting conditions.

Gross motor function is commonly classified using the Gross Motor Function Classification System (GMFCS), which describes functional mobility in children with CP. Previous studies have reported an

association between greater motor impairment and respiratory complications; however, it remains unclear whether gross motor function itself is independently associated with recurrent pneumonia-related hospitalization after considering other relevant clinical characteristics ([Blackmore et al., 2016a](#); [Hafifah et al., 2018](#)). This question is particularly relevant because children with severe motor impairment may also have gastrointestinal, nutritional, airway, and neurological comorbidities.

Therefore, further evaluation of the association between gross motor function and recurrent pneumonia-related hospitalization is needed. Understanding this association may help identify clinical characteristics associated with repeated hospitalization among children with CP who have previously experienced pneumonia-related hospitalization. This study aimed to determine the association between gross motor function and recurrent pneumonia-related hospitalization in children with cerebral palsy.

SUBJECTS AND METHOD

1. Study Design

This cross-sectional study was conducted at the Pediatric Neurology Outpatient Clinic of Dr. Moewardi Regional General Hospital, Surakarta, Indonesia, from May to July 2025. The study aimed to assess the association between gross motor function and recurrent pneumonia-related hospitalization in children with cerebral palsy. Gross motor function and the assessed comorbidities were evaluated during the study period, whereas pneumonia-related hospitalization data were retrospectively obtained from electronic medical records for the period 2022–2025.

2. Population and Sample

The target population was children with cerebral palsy. The source population

comprised children aged 1–18 years with cerebral palsy who attended the Pediatric Neurology Outpatient Clinic and had experienced at least one previous pneumonia-related hospitalization. Thus, all participants had a history of pneumonia-related hospitalization at study entry. Children with congenital heart disease were excluded. Participants were recruited using consecutive sampling. The minimum sample size was initially estimated using a rule of thumb of 10 subjects per independent variable. Based on seven prespecified variables, a minimum sample size of 70 subjects was required; 77 children were enrolled.

3. Study Variables

The independent variable was gross motor function level. The dependent variable was recurrent pneumonia-related hospitalization. Potential confounding variables included sex, cerebral palsy type, nutritional status, gastrointestinal disorders, airway abnormalities, and epilepsy.

4. Operational Definition of Variables

Gross motor function was assessed during the study period from May to July 2025 using the Gross Motor Function Classification System (GMFCS) and categorized as GMFCS levels I–II or GMFCS levels III–V. The nutritional status, gastrointestinal disorders, airway abnormalities, and epilepsy, were evaluated during the same study period using clinical assessments, interviews, and electronic medical records.

Pneumonia-related hospitalization was retrospectively assessed using electronic medical records at Dr. Moewardi Regional General Hospital during 2022–2025. Each separately documented pneumonia-related hospitalization episode was counted as one hospitalization. Participants were categorized as having non-recurrent hospitalization if they had one hospitalization

episode and recurrent hospitalization if they had more than one hospitalization episode during the observation period. Cerebral palsy type was categorized as spastic or other.

Gastrointestinal disorders were defined by the presence of drooling, dysphagia, or constipation.

Nutritional status was categorized as malnutrition or no malnutrition.

Airway abnormalities included structural airway or lung pathology.

Epilepsy was defined according to International League Against Epilepsy criteria.

5. Study Instruments

Gross motor function was classified using GMFCS. Drooling was assessed using the Thomas-Stonell and Greenberg scale, dysphagia using the Eating and Drinking Ability Classification System (EDACS), and constipation using Rome criteria. Nutritional status was assessed from anthropometric measurements using the WHO 2006 growth chart for children up to 5 years and the CDC 2000 growth chart for children aged 5–18 years. Knee height was used to estimate height when standing height could not be measured. Data were obtained from history taking, physical examination, and electronic medical records.

6. Data Analysis

Baseline characteristics were summarized as frequencies and percentages. Bivariate associations with recurrent pneumonia-related hospitalization were assessed using the Chi-square test or Fisher exact test, as appropriate. Variables with $p < 0.250$ in bivariate analysis were entered into a multivariable binary logistic regression model. Associations are reported as odds ratios (OR) with 95% confidence intervals (CI), with $p < 0.050$ considered statistically significant. No missing data were identified among the variables.

7. Research Ethic

Ethical approval was obtained from the Health Research Ethics Committee of Dr. Moewardi Regional General Hospital before study initiation. Informed consent was obtained from the participants' parents or guardians, and participant confidentiality was maintained. The ethical clearance approval number was 918/IV/HREC/2025.

RESULTS

1. Sample Characteristics

A total of 77 children with cerebral palsy were included. The mean age was 5.09 years (SD= 4.14; range 1-17 years). Recurrent pneumonia-related hospitalization occurred in 34 of 77 children with CP (44.2%) in this study. GMFCS levels III-V were present in 71.43% of participants. Most participants were male (62.34%) and had spastic cerebral palsy (89.61%). Malnutrition was present in 66.23%, gastrointestinal disorders in 72.73%, airway abnormalities in 10.39%, and epilepsy in 59.74%. The detailed characteristics of the study participants are presented in Table 1.

Table 1. Sample Characteristics of Participants

Variable	n	%
Sex		
Male	48	62.34
Female	29	37.66
Type of cerebral palsy		
Spastic	69	89.61
Hypotonic	8	10.39
Gross motor function		
GMFCS level III-V	55	71.43
GMFCS level I-II	22	28.57
Nutritional status		
Malnutrition	51	66.23
No malnutrition	26	33.77
Gastrointestinal disorder		
Present	56	72.73
Absent	21	27.27
Airway abnormalities		
Present	8	10.39
Absent	69	89.61
Epilepsy		
Present	46	59.74
Absent	31	40.26

2. Pretest and Posttest Knowledge Scores

Gross motor function and gastrointestinal disorders were associated with recurrent pneumonia-related hospitalization. Children with GMFCS levels III-V had higher odds of recurrent hospitalization than those with GMFCS levels I-II (OR= 8.18; 95% CI= 2.17 to 30.90; p= 0.001).

Gastrointestinal disorders were also associated with recurrent hospitalization (OR= 7.44; 95% CI= 1.97 to 28.10; p= 0.001). Sex (p= 0.130), cerebral palsy type (p= 1.000), nutritional status (p= 0.472), airway abnormalities (p= 0.454), and epilepsy (p= 0.208) were not statistically associated with recurrent hospitalization.

The results of the bivariate analysis are presented in Table 2.

Table 2. Bivariate analysis of factors associated with recurrent pneumonia-related hospitalization in children with cerebral palsy

Variables	Hospitalization		95% CI		p	OR
	Recurrent (n=34)	Not recurrent (n=43)	Lower limit	Upper limit		
Sex						
Male	18 (52.9%)	30 (69.8%)	0.19	1.24	0.130	0.49
Female	16 (47.1%)	13 (30.2%)				
Type of cerebral palsy						
Spastic	31 (91.2%)	38 (88.4%)	0.30	6.17	1.000	1.36
Hypotonic	3 (8.8%)	5 (11.6%)				
Gross motor function						
GMFCS level III-V	31 (91.2%)	24 (55.8%)	2.17	30.90	0.001	8.18
GMFCS level I-II	3 (8.8%)	19 (44.2%)				
Nutritional status						
Malnutrition	24 (70.6%)	27 (62.8%)	0.54	3.73	0.472	1.42
No malnutrition	10 (29.4%)	16 (37.2%)				
Gastrointestinal disorders						
Present	31 (91.2%)	25 (58.1%)	1.97	28.10	0.001	7.44
Absent	3 (8.8%)	18 (41.9%)				
Airway abnormalities						
Present	5 (14.7%)	3 (7%)	0.51	10.40	0.454	2.30
Absent	29 (85.3%)	40 (93.0%)				
Epilepsy						
Present	23 (67.6%)	23 (53.5%)	0.72	4.62	0.208	1.82
Absent	11 (32.4%)	20 (46.5%)				

* Note: GMFCS = Gross Motor Function Classification System; OR = Odds Ratio; 95% CI = 95% confidence interval; SD = Standard Deviation.

3. Multivariate Analysis

After adjustment for sex, gastrointestinal disorders, and epilepsy, GMFCS levels III-V remained independently associated with recurrent pneumonia-related hospitalization (OR= 4.50; 95% CI= 1.01 to 20.09; p= 0.049). Sex (OR= 0.39; 95% CI= 0.13 to

1.16; p= 0.091), gastrointestinal disorders (OR= 4.06; 95% CI= 0.88 to 18.76; p= 0.073), and epilepsy (OR= 1.49; 95% CI= 0.51 to 4.33; p= 0.463) were not statistically significant in the adjusted model. The results of the multivariate logistic regression analysis are presented in Table 3.

Table 3. Multivariate analysis of factors associated with recurrent pneumonia-related hospitalization in children with cerebral palsy

Independent Variables	OR	95% CI		p
		Lower limit	Upper limit	
Sex				
Male	0.39	0.13	1.16	0.091
Female				
Gross motor function				
GMFCS level III-V	4.50	1.01	20.09	0.049
GMFCS level I-II				

Independent Variables	OR	95% CI		p
		Lower limit	Upper limit	
Gastrointestinal disorders				
Present	4.06	0.88	18.76	0.073
Absent				
Epilepsy				
Present	1.49	0.51	4.33	0.463
Absent				

*Note: GMFCS = Gross Motor Function Classification System; OR = Odds Ratio; 95% CI = 95% confidence interval.

DISCUSSION

Cerebral palsy is a permanent, non-progressive neurodevelopmental disorder characterized by motor and postural impairment that restricts daily activities ([Hallman-Cooper and Cabrero, 2024](#)). Cerebral palsy is a heterogeneous condition characterized by diverse etiologies, clinical manifestations, comorbidities, management approaches, and outcomes. Respiratory symptoms, including cough, choking, changes in voice, and feeding-related regurgitation, are common in children and young people with CP and may reflect swallowing dysfunction and aspiration ([Blackmore et al., 2016a](#); [Ismael and Soetomenggolo, 2022](#)).

Respiratory illness is an important cause of morbidity, mortality, hospitalization, and reduced quality of life in children with CP, particularly among those with severe impairment ([Marpole et al., 2020](#)). Population-based data have also shown that respiratory causes, particularly pneumonia, account for a substantial proportion of deaths among people with CP, including deaths occurring during childhood ([Blair et al., 2019](#)).

Recurrent pneumonia-related hospitalization occurred in 34 of 77 children with CP (44.16%) in this study. This finding is consistent with previous reports reporting a substantial burden of respiratory-related hospitalization in CP, with pneumonia accounting for 91% of admissions in a

Turkish cohort and a respiratory-related readmission rate of approximately 41% in an Australian cohort ([Blackmore et al., 2018](#); [Çakar and Cinel, 2021](#)). Male subjects predominated in this study, accounting for 62.3% of the subjects, which is consistent with the higher prevalence of CP reported among males ([Chiang et al., 2019](#); [Kuo et al., 2020](#)).

However, sex was not significantly associated with recurrent pneumonia-related hospitalization in either the bivariate or multivariate analysis. A large cohort study also reported that severe pneumonia was more common in male children with CP than in females. This increased susceptibility has been attributed to biological differences in airway development and immune responses between sexes. However, these factors may not be sufficient to independently influence the risk of recurrent pneumonia-related hospitalization ([Kuo et al., 2020](#)). The lack of association observed in this study may reflect the stronger influence of other clinical factors, particularly gross motor impairment and gastrointestinal disorders, on the risk of recurrent hospitalization.

Most subjects had spastic CP (89.61%). This finding reflects the predominance of the spastic subtype in the general CP population, which has been attributed to the vulnerability of upper motor neurons in the pyramidal tract during the perinatal period ([Hallman-Cooper and Cabrero,](#)

[2024](#); [Ismael and Soetomenggolo, 2022](#); [Marcdante and Kliegman, 2023](#)). Cerebral palsy type was not significantly associated with recurrent pneumonia-related hospitalization in the present study. Although previous studies have reported increased hospitalization rates among children with triplegic and quadriplegic spastic CP subtypes, evidence specifically linking CP type to recurrent pneumonia-related hospitalization remains limited ([Fortin et al., 2021](#)). The absence of an association in this study may be explained by the small number of non-spastic cases and the inability of broad CP subtype classification to capture differences in disease severity and functional impairment.

Severe gross motor impairment was common in this cohort, with 71.43% of subjects classified as GMFCS levels III–V. Multivariate analysis showed that severe motor impairment was independently associated with recurrent pneumonia-related hospitalization, with the odds of recurrence being approximately 4.5 times higher among patients with severe motor impairment. This finding is supported by prior studies demonstrating a higher burden of recurrent respiratory-related hospitalization among children with greater functional limitations ([Meehan et al., 2025](#); [Hafifah et al., 2018](#)). However, some studies have reported that the association between GMFCS level and respiratory hospitalization attenuates after adjustment for other clinical factors, suggesting that gross motor impairment may interact with additional comorbidities ([Blackmore et al., 2018](#); [Blackmore et al., 2020](#)).

The observed association may reflect the broader clinical consequences of severe motor impairment, including respiratory muscle weakness, ineffective cough, impaired airway clearance, and skeletal complications such as scoliosis, which may

contribute to respiratory morbidity ([Peneva et al., 2023](#); [McLeod et al., 2024](#)). However, the single-center design and limited sample size may have introduced selection bias and reduced the precision and generalizability of the findings. The cross-sectional design also limits assessment of temporality and causality. Therefore, these findings indicate an independent association between severe motor impairment and recurrent pneumonia-related hospitalization, rather than a causal or predictive relationship.

Malnutrition was present in 66.23% of subjects, ranging from overweight to underweight and severe underweight. However, no significant association was found between nutritional status and frequency of pneumonia-related hospitalization. While some studies have identified malnutrition as a risk factor for respiratory morbidity in children with CP, our findings are in line with other reports showing no significant association ([Hafifah et al., 2018](#); [Leonard et al., 2019](#)). This discrepancy may be explained by differences in outcome definitions, limited sample size, and the classification of all forms of malnutrition into a single category, which may have obscured the effect of severity. Malnutrition in children with CP is often caused by feeding difficulties, including dysphagia, gastroesophageal reflux, constipation, poor feeding posture, and dependence on caregivers for feeding. In turn, infections can worsen nutritional status by reducing appetite and increasing metabolic demands, creating a cycle that ultimately impairs treatment effectiveness and quality of life ([Leonard et al., 2019](#); [Foster et al., 2020](#); [Kirolos et al., 2021](#)).

More than two-thirds of the subjects (72.73%) exhibited gastrointestinal disorders, including drooling, dysphagia, or constipation. These conditions were combined into a single composite variable

to maintain model parsimony, as analyzing them separately would increase the number of predictors and require a larger sample size than was available in this single-center study. Although gastrointestinal disorders were significantly associated with recurrent pneumonia-related hospitalization in the bivariate analysis, the association was no longer significant after adjustment for other variables. Previous studies have identified dysphagia and gastroesophageal reflux as important risk factors for respiratory morbidity in children with CP, primarily through chronic aspiration ([Blackmore et al., 2018](#)). Another previous study found that swallowing difficulties were highly prevalent among hospitalized children with CP but were not significantly associated with hospitalization frequency. Similarly, constipation showed no significant association with hospitalization, and delayed nutritional intervention was proposed as a contributor to aspiration-related pulmonary damage ([Çakar and Cinel, 2021](#)). This finding should be interpreted cautiously because the composite classification may have obscured condition-specific associations, particularly as dysphagia and drooling may have a more direct relationship with aspiration risk than constipation. Future studies with larger samples and standardized assessment of individual conditions are needed to clarify their independent associations with recurrent pneumonia-related hospitalization.

Laryngomalacia was the only airway abnormality identified, affecting 10.39% of the subjects. Despite its presence, airway abnormalities did not significantly influence the risk of recurrent pneumonia-related hospitalization ([Peneva et al., 2023](#)). Previous studies suggest that laryngomalacia may increase the risk of respiratory-related hospitalization, especially among children with neurological comor-

bidity. However, swallowing dysfunction and chronic aspiration are generally considered the primary contributors to recurrent pneumonia in children with CP ([Kim et al., 2026](#)).

Epilepsy was present as a comorbidity in 59.74% of subjects but was not significantly associated with recurrent pneumonia-related hospitalization. This finding differs from previous studies that identified epilepsy as a risk factor for respiratory morbidity and hospitalization in children with CP ([Blackmore et al., 2020](#); [Kuo et al., 2020](#)). Seizures may increase the risk of respiratory complications through impaired airway protection, aspiration during seizure episodes, and the sedative and sialogenic effects of antiepileptic medications such as benzodiazepines ([Blackmore et al., 2018](#); [Marpole et al., 2020](#)). The lack of association observed in this study may be related to the relatively smaller sample size compared with previous studies and the absence of detailed data on seizure severity, frequency, and the antiepileptic regimen.

This study has several limitations. First, the cross-sectional design limits the ability to establish a causal relationship between gross motor function and recurrent pneumonia-related hospitalization. Second, including only children with a history of pneumonia-related hospitalization may have introduced selection bias and limited the generalizability of the findings to the broader population of children with cerebral palsy. The single-center design, relatively small sample size, and wide confidence interval for GMFCS level III–V also indicate limited representativeness, statistical power, and precision of the estimates. Third, gastrointestinal disorders were analyzed as a composite variable, and the severity of individual conditions such as dysphagia, drooling, and constipation was not fully assessed. Finally, retrospective

electronic medical records may have resulted in incomplete or misclassified data.

In conclusion, GMFCS levels III-V were independently associated with higher odds of recurrent pneumonia-related hospitalization in children with cerebral palsy. The findings suggest that GMFCS level may be clinically relevant when assessing children with cerebral palsy who have a history of pneumonia-related hospitalization. Children with GMFCS levels III-V may therefore warrant closer respiratory monitoring and multidisciplinary assessment of associated feeding, nutritional, and airway problems. However, this should be considered a potential clinical consideration, as the study did not assess the impact of GMFCS-based monitoring on outcomes. Prospective multi-center studies are needed to validate these findings and determine their clinical utility.

AUTHOR CONTRIBUTION

NA: Conceptualization, methodology, data collection, data analysis, interpretation of results, and manuscript writing. FTN: Supervision, interpretation of results, critical revision of the manuscript, and final approval of the manuscript. AW: Supervision, interpretation of results, critical revision of the manuscript, and final approval of the manuscript.

CONFLICT OF INTEREST

There are no conflicts of interest.

FUNDING AND SPONSORSHIP

None.

ACKNOWLEDGEMENT

None.

REFERENCES

- Blackmore AM, Bear N, Blair E, Gibson N, Jalla C, Langdon K, Moshovis L, et al. (2016a). Prevalence of symptoms associated with respiratory illness in children and young people with cerebral palsy. *Dev Med Child Neurol*. 58: 780-781. <https://doi.org/10.1111/dm-cn.13016>.
- Blackmore AM, Bear N, Blair E, Gibson N, Jalla C, Langdon K, Moshovis L, et al. (2016b). Factors associated with respiratory illness in children and young adults with cerebral palsy. *J Pediatr*. 168: 151-157.e1. <https://doi.org/10.1016/j.jpeds.2015.09.064>.
- Blackmore AM, Bear N, Blair E, Langdon K, Moshovis L, Steer K, Wilson AC (2018). Predicting respiratory hospital admissions in young people with cerebral palsy. *Arch Dis Child*. 103: 1119-1124. <https://doi.org/10.1136/archdischild-2017-314346>.
- Blackmore AM, Bear N, Langdon K, Moshovis L, Gibson N, Wilson A (2020). Respiratory hospital admissions and emergency department visits in young people with cerebral palsy: 5-year follow-up. *Arch Dis Child*. 105: 1126-1127. <https://doi.org/10.1136/archdischild-2019-317714>.
- Blair E, Langdon K, McIntyre S, Lawrence D, Watson L (2019). Survival and mortality in cerebral palsy: observations to the sixth decade from a data linkage study of a total population register and National Death Index. *BMC Neurol*. 19: 111. <https://doi.org/10.1186/s12883-019-1343-1>.
- Çakar MK, Cinel G (2021). The respiratory problems of patients with cerebral palsy requiring hospitalization: reasons and solutions. *Pediatr Pulmonol*. 56(6): 1626-1634. <https://doi.org/10.1002/ppul.25306>.

- Chiang KL, Huang CY, Fan HC, Kuo FC (2019). Prolonged length of stay for acute hospital admissions as the increasing of age: a nationwide population study for Taiwan's patients with cerebral palsy. *Pediatr Neonatol*. 60: 74-82. <https://doi.org/10.1016/j.ped-neo.2018.04.004>.
- Fortin O, Ng P, Dorais M, Koclas L, Pigeon N, Shevell M, Oskoui M (2021). Hospitalizations in school-aged children with cerebral palsy and population-based controls. *Can J Neurol Sci*. 48(3): 400-407. <https://doi.org/10.1017/cjn.2020.199>.
- Foster BA, Lane JE, Massey E, Noelck M, Green S, Austin JP (2020). The impact of malnutrition on hospitalized children with cerebral palsy. *Hosp Pediatr*. 10(12): 1087. <https://doi.org/10.1542/hpeds.2020-0177>.
- Hafifah CN, Setyanto DB, Putra ST, Mangunatmadja I, Sari TT, Wulandari HF (2018). Gross motor dysfunction as a risk factor for aspiration pneumonia in children with cerebral palsy. *Paediatr Indones*. 57(5): 229. <https://doi.org/10.14238/pi57.5.2017.229-33>.
- Hallman-Cooper JL, Cabrero FR (2024). Cerebral palsy. In: StatPearls. Treasure Island, FL: StatPearls Publishing. Retrieved from: <https://www.ncbi.nlm.nih.gov/books/NBK538147/>
- Ismael S, Setyo H (2022). Buku ajar neurologi anak, Edisi 1 (Pediatric Neurology Textbook, first edition). Jakarta: Badan Penerbit IDAI.
- Kim Y, Kang J, Yun MS, Jung S (2026). Cluster analysis of laryngomalacia in infants: insights into prognostic factors from a 10-year cohort. *Allergy Asthma Respir Dis*. 14(2): 84-92. <https://doi.org/10.4168/aard.2026.14.2.84>.
- Kirollos A, Blacow RM, Parajuli A, Welton NJ, Khanna A, Allen SJ, McAllister DA, et al. (2021). The impact of childhood malnutrition on mortality from pneumonia: a systematic review and network meta-analysis. *BMJ Glob Health*. 6: e007411. <https://doi.org/10.1136/bmjgh-2021-007411>.
- Kuo TJ, Hsu CL, Liao PH, Huang SJ, Hung YM, Yin CH (2020). Nomogram for pneumonia prediction among children and young people with cerebral palsy: a population-based cohort study. *PLoS One*. 15: e0235069. <https://doi.org/10.1371/journal.pone.0235069>.
- Leonard M, Dain E, Pelc K, Dan B, Laet C (2019). Nutritional status of neurologically impaired children: impact on comorbidity. *Arch Pediatr*. 27(2):95-103. <https://doi.org/10.1016/j.arcpe-d.2019.11.003>.
- Marcdante KJ, Kliegman RM (2023). Evaluation of child with special needs. In: Nelson essentials of pediatrics-eighth edition. Elsevier Health Sciences.
- Marpole R, Blackmore AM, Gibson N, Cooper MS, Langdon K, Wilson AC (2020). Evaluation and management of respiratory illness in children with cerebral palsy. *Front Pediatr*. 8: 333. <https://doi.org/10.3389/fped.2020.00333>.
- Mcleod S, Makino A, Kawamura A (2024). Position statement care for children and youth with cerebral palsy (GMFCS levels III to V). *Paediatr Child Health*. 29(3):189-192. <https://doi.org/10.1093/pch/pxae003>.
- Meehan E, Freed GL, Reid SM, Williams K, Sewell JR, Rawicki B, Reddiough DS (2025). Tertiary paediatric hospital admissions in children and young people with cerebral palsy. *Child Care*

Health Dev. 41: 928-937. <https://doi.org/10.1111/cch.12263>.

Peneva P, Pancheva R, Nikolova SP (2023). Unveiling respiratory challenges in cerebral palsy: a comprehensive

review. Biomedical Reviews. 34: 121. <http://dx.doi.org/10.14748/bmr.v34.9620>.