

## Nutritional and Infant Feeding Factors Associated with Severity of Pneumonia in Children Aged 2 Months to 5 Years

Rajashekhar B. Kenganal<sup>1</sup>, Nandhini Lakshminarayan<sup>2</sup>, Guruprasad N.<sup>3</sup>

<sup>1</sup>Assistant Professor, Department of paediatrics, Farookh Academy of Medical Education Hospital & Research Institute, Mysuru, Karnataka

<sup>2</sup>Assistant Professor, Department of paediatrics, Farookh Academy of Medical Education Hospital & Research Institute, Mysuru, Karnataka

<sup>3</sup>Assistant Professor, Department of paediatrics, Farookh Academy of Medical Education Hospital & Research Institute, Mysuru, Karnataka

Received: 03-07-2026 / Revised: 22-07-2026 / Accepted: 11-08-2026

Corresponding author: Dr. Guruprasad N

Conflict of interest: Nil

### Abstract

**Background:** Pneumonia severity in young children may be influenced by nutritional status and early feeding practices. Identifying modifiable factors may help reduce severe disease.

**Objective:** To assess the association of nutritional status and infant feeding practices with pneumonia severity in children aged 2 months to 5 years.

**Materials and Methods:** A prospective observational study was conducted among 120 children admitted with pneumonia at ESICMC & PGIMSR, Bengaluru, from January 2019 to June 2020. Birth weight, breastfeeding, bottle feeding, weaning practices, weight-for-age, height/length-for-age, MUAC and anemia were assessed. Associations with severe/very severe pneumonia were evaluated using the chi-square test.

**Results:** Low birth weight, bottle feeding, underweight, stunting and MUAC-defined malnutrition were significantly associated with severe/very severe pneumonia, whereas exclusive breastfeeding, early weaning and anemia were not significantly associated.

**Conclusion:** Low birth weight and nutritional deficits, particularly stunting and MUAC-defined malnutrition, were important correlates of severe pneumonia.

**Keywords:** Pneumonia; Malnutrition; Breastfeeding; Bottle Feeding; Low Birth Weight; Stunting; MUAC; Children.

**DOI:** 10.25258/ijcpr.18.8.129

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

### Introduction

Pneumonia continues to be an important cause of illness and death among children younger than five years, particularly in low- and middle-income countries. Although global childhood pneumonia mortality has declined, substantial morbidity remains concentrated in vulnerable populations, with nutritional deficiencies contributing to susceptibility and poor outcomes [1]. The severity of childhood pneumonia is determined by a combination of host, environmental and disease-related factors, and nutritional status is among the potentially modifiable determinants [2].

Low birth weight may increase vulnerability to respiratory infections through impaired lung development, reduced physiological reserve and altered immune responses. Hospital-based studies from India have also identified low birth weight and other clinical factors as important determinants

of poor outcomes in children with severe pneumonia [3]. In addition, inadequate infant feeding practices may influence susceptibility to respiratory infection [4]. Exclusive breastfeeding provides nutritional and immunological protection during early life, while inappropriate feeding practices may contribute to childhood infection and poor nutritional status [5].

Childhood undernutrition is particularly relevant because infection and malnutrition can reinforce each other. Nutritional deficits may impair immune responses and increase the likelihood of severe infection, while acute infection can further compromise nutritional status [6]. However, the relationship of specific nutritional indicators and infant-feeding practices with pneumonia severity may vary across populations. Therefore, the present study was undertaken to evaluate the association of

low birth weight, breastfeeding and feeding practices, anthropometric nutritional status and anemia with pneumonia severity among children aged 2 months to 5 years admitted to a tertiary-care hospital.

### Material and Methods

A prospective observational study was conducted in the Department of Paediatrics, ESICMC & PGIMSR, Rajajinagar, Bengaluru, from January 2019 to June 2020. Children aged 2 months to 5 years admitted with pneumonia during the study period were enrolled. A total of 120 eligible children were included.

### Inclusion Criteria

- Children aged 2 months to 5 years admitted with pneumonia during the study period.

### Exclusion Criteria

- Children with congenital heart disease.
- Children with tuberculosis, HIV or primary immunodeficiency.
- Children with congenital lung malformations.

**Data Collection:** Pneumonia was assessed using age-specific clinical criteria. Lower chest-wall indrawing was considered severe pneumonia, while refusal of feeds, central cyanosis, lethargy or

convulsions indicated very severe pneumonia. A detailed history and physical examination were performed, along with routine hematological investigations and chest radiography.

**Nutritional and Feeding Assessment:** Birth weight, exclusive breastfeeding up to 6 months, bottle feeding and early weaning were recorded.

Nutritional status was assessed using weight-for-age, height/length-for-age and MUAC according to IAP and WHO criteria. Anemia was assessed by hemoglobin level, with Hb <11 g/dL considered anemia in children aged 6–59 months.

**Statistical Analysis:** Categorical variables were expressed as frequencies and percentages. Associations between nutritional and feeding factors and pneumonia severity were assessed using the Chi-square test. A p-value <0.05 was considered statistically significant. Statistical analysis was performed using SPSS.

### Results

A total of 120 children aged 2 months to 5 years were included in the analysis. The results specifically examined nutritional status, birth weight and infant-feeding practices in relation to pneumonia severity.

**Table 1: Nutritional and infant-feeding characteristics of study participants (N=120)**

| Variable                               | Category | Number | Percentage |
|----------------------------------------|----------|--------|------------|
| Birth weight                           | ≥2500 g  | 87     | 72.5%      |
|                                        | <2500 g  | 33     | 27.5%      |
| Exclusive breastfeeding up to 6 months | Yes      | 76     | 63.3%      |
|                                        | No       | 44     | 36.7%      |
| Bottle feeding in infancy              | Yes      | 68     | 56.7%      |
|                                        | No       | 52     | 43.3%      |
| Early weaning                          | Yes      | 44     | 36.7%      |
|                                        | No       | 76     | 63.3%      |

Most children had a birth weight ≥2500 g (72.5%) and 63.3% had been exclusively breastfed up to 6 months. Bottle feeding was reported in 56.7%, while early weaning was reported in 36.7% of children. These findings indicate that potentially modifiable infant-feeding practices were relatively common in the study population.

**Table 2: Anthropometric and nutritional status of study participants**

| Nutritional indicator | Category                 | Number | Percentage |
|-----------------------|--------------------------|--------|------------|
| Weight-for-age        | Normal                   | 90     | 75%        |
|                       | PEM Grade I              | 10     | 8.3%       |
|                       | PEM Grade II             | 8      | 6.7%       |
|                       | PEM Grade III            | 8      | 6.7%       |
|                       | PEM Grade IV             | 4      | 3.3%       |
| Height/length-for-age | Normal                   | 97     | 80.8%      |
|                       | Moderate/severe stunting | 23     | 19.2%      |
| MUAC                  | Normal                   | 95     | 79.1%      |
|                       | Mild malnutrition        | 5      | 4.3%       |
|                       | Moderate malnutrition    | 11     | 9.1%       |
|                       | Severe malnutrition      | 9      | 7.5%       |

Three-fourths of the children had normal weight-for-age, while 25% had some degree of protein-energy malnutrition. Moderate/severe stunting was present in 19.2%, and 20.9% had MUAC-defined malnutrition.

**Table 3: Association of low birth weight with pneumonia severity**

| Birth weight | Pneumonia n (%) | Severe/very severe n (%) | Total | p-value |
|--------------|-----------------|--------------------------|-------|---------|
| ≥2500 g      | 68 (78.1%)      | 19 (21.8%)               | 87    | <0.001  |
| <2500 g      | 12 (36.3%)      | 21 (63.6%)               | 33    |         |

Severe/very severe pneumonia was substantially more frequent among children with low birth weight than among those with birth weight ≥2500 g (63.6% vs. 21.8%). The association was statistically significant ( $p<0.001$ ).

**Table 4: Association of infant-feeding practices with severity of pneumonia**

| Feeding factor          | Category | Pneumonia n (%) | Severe/very severe n (%) | Total | p-value |
|-------------------------|----------|-----------------|--------------------------|-------|---------|
| Exclusive breastfeeding | Yes      | 54 (71.1%)      | 22 (28.9%)               | 76    | 0.18    |
|                         | No       | 26 (59.1%)      | 18 (40.9%)               | 44    |         |
| Early weaning           | Yes      | 26 (59.1%)      | 18 (40.9%)               | 44    | 0.18    |
|                         | No       | 54 (71.1%)      | 22 (28.9%)               | 76    |         |
| Bottle feeding          | Yes      | 38 (55.9%)      | 30 (44.1%)               | 68    | 0.004   |
|                         | No       | 42 (80.8%)      | 10 (19.2%)               | 52    |         |

Severe/very severe pneumonia occurred in 40.9% of children who were not exclusively breastfed compared with 28.9% of those exclusively breastfed; however, this difference was not statistically significant ( $p=0.18$ ). Similarly, early weaning was not significantly associated with

severity ( $p=0.18$ ). In contrast, bottle feeding showed a significant association, with severe/very severe pneumonia occurring in 44.1% of bottle-fed children compared with 19.2% of children without a history of bottle feeding ( $p=0.004$ ).

**Table 5: Association of weight-for-age with severity of pneumonia**

| Weight-for-age | Pneumonia n (%) | Severe/very severe n (%) | Total | p-value |
|----------------|-----------------|--------------------------|-------|---------|
| Normal         | 66 (73.3%)      | 24 (26.7%)               | 90    | 0.0073  |
| PEM Grade I    | 6 (60%)         | 4 (40%)                  | 10    |         |
| PEM Grade II   | 4 (50%)         | 4 (50%)                  | 8     |         |
| PEM Grade III  | 3 (37.5%)       | 5 (62.5%)                | 8     |         |
| PEM Grade IV   | 1 (25%)         | 3 (75%)                  | 4     |         |

There was a progressive increase in the proportion of severe/very severe pneumonia with worsening weight-for-age nutritional status. Severe/very severe pneumonia was present in 26.7% of children with normal weight-for-age compared with 75.0% of those with Grade IV PEM. This association was statistically significant ( $p=0.0073$ ).

**Table 6: Association of stunting and MUAC-defined malnutrition with pneumonia severity**

| Nutritional parameter | Category              | Pneumonia n (%) | Severe/very severe n (%) | Total | p-value |
|-----------------------|-----------------------|-----------------|--------------------------|-------|---------|
| Height/length-for-age | Normal                | 73 (75.3%)      | 24 (24.7%)               | 97    | <0.001  |
|                       | Stunted               | 7 (30.4%)       | 16 (69.6%)               | 23    |         |
| MUAC                  | Normal                | 69 (72.6%)      | 26 (27.4%)               | 95    | 0.007   |
|                       | Mild malnutrition     | 2 (40%)         | 3 (60%)                  | 5     |         |
|                       | Moderate malnutrition | 5 (45.5%)       | 6 (54.5%)                | 11    |         |
|                       | Severe malnutrition   | 4 (44.4%)       | 5 (55.6%)                | 9     |         |

Stunting was strongly associated with pneumonia severity. Severe/very severe pneumonia occurred in 69.6% of stunted children compared with 24.7% of children with normal height/length-for-age ( $p<0.001$ ). MUAC-defined malnutrition was also

significantly associated with severity, with severe/very severe pneumonia occurring in more than half of children with MUAC-defined malnutrition compared with 27.4% of children with normal MUAC ( $p=0.007$ ).

**Table 7: Association of anemia with pneumonia severity**

| Anemia    | Pneumonia n (%) | Severe/very severe n (%) | Total | p-value |
|-----------|-----------------|--------------------------|-------|---------|
| No anemia | 23 (63.9%)      | 13 (36.1%)               | 36    | 0.41    |
| Mild      | 40 (81.6%)      | 9 (18.4%)                | 49    |         |
| Moderate  | 16 (50%)        | 16 (50%)                 | 32    |         |
| Severe    | 1 (33.3%)       | 2 (66.7%)                | 3     |         |

Although severe/very severe pneumonia was more frequent among children with moderate and severe anemia, the overall association between anemia severity and pneumonia severity was not statistically significant ( $p=0.41$ ).

### Discussion

The present study found that low birth weight, bottle feeding and poor nutritional status were significantly associated with severe/very severe pneumonia, whereas exclusive breastfeeding, early weaning and anemia did not show statistically significant associations. These findings suggest that nutritional vulnerability and certain early feeding practices may influence the clinical severity of pneumonia among young children.

Low birth weight showed one of the strongest associations in the present study. Nearly two-thirds of children weighing <2500 g had severe/very severe pneumonia compared with about one-fifth of children with birth weight  $\geq 2500$  g. This finding is consistent with previous evidence identifying low birth weight as an important risk factor for severe pneumonia in children under five years of age [7]. Low birth weight may be associated with reduced physiological reserve and impaired respiratory and immune development, potentially increasing vulnerability to severe respiratory infection.

Bottle feeding was significantly associated with pneumonia severity, with severe/very severe disease occurring in 44.1% of bottle-fed children compared with 19.2% of children without a history of bottle feeding. In contrast, exclusive breastfeeding was associated with a lower proportion of severe disease, although the difference was not statistically significant in the present study. Recent evidence from children under five years has reported higher odds of severe pneumonia among those who were not exclusively breastfed for the first six months [9]. The absence of statistical significance in the present study may partly reflect its relatively small sample size. The association between nutritional status and pneumonia severity was particularly consistent. The proportion of severe/very severe pneumonia increased progressively with worsening weight-for-age, while stunting and MUAC-defined malnutrition were also significantly associated with severe disease. Similar findings have been reported in children with community-acquired severe pneumonia, where severe stunting was associated

with severe disease [8]. A recent study from Egypt also demonstrated a high prevalence of underweight, stunting and wasting among under-five children with pneumonia and showed adverse effects of malnutrition on clinical outcomes [10]. Undernutrition may impair immune function and reduce the child's ability to mount an effective response to infection.

Although anemia was common in the study population, no significant association was observed between anemia severity and pneumonia severity. This suggests that anemia alone may not be a consistent marker of pneumonia severity in this population. Overall, the findings emphasize the importance of adequate nutrition, appropriate infant-feeding practices and early identification of nutritional vulnerability in children presenting with pneumonia.

### Conclusion

Low birth weight, bottle feeding and poor nutritional status were significantly associated with severe/very severe pneumonia among children aged 2 months to 5 years. Weight-for-age malnutrition, stunting and MUAC-defined malnutrition showed particularly clear relationships with disease severity. Although exclusive breastfeeding was associated with a lower proportion of severe disease, the difference was not statistically significant, while early weaning and anemia were also not significantly related to severity.

The findings highlight the importance of adequate nutrition, appropriate infant-feeding practices and measures to reduce low birth weight as potentially modifiable components of childhood pneumonia prevention. Early identification of nutritional vulnerability among children presenting with pneumonia may also help clinicians anticipate a more severe clinical course.

### References

- McAllister DA, Liu L, Shi T, Chu Y, Reed C, Burrows J, Adeloje D, Rudan I, Black RE, Campbell H, Nair H. Global, regional, and national estimates of pneumonia morbidity and mortality in children younger than 5 years between 2000 and 2015: a systematic analysis. *Lancet Glob Health*. 2019 Jan;7(1):e47-e57. doi: 10.1016/S2214-109X(18)30408-X.
- Dean P, Florin TA. Factors Associated With Pneumonia Severity in Children: A Systematic

- Review. J Pediatric Infect Dis Soc. 2018 Dec 3;7(4):323-334. doi: 10.1093/jpids/piy046.
3. Jakhar SK, Pandey M, Shah D, Ramachandran VG, Saha R, Gupta N, Gupta P. Etiology and Risk Factors Determining Poor Outcome of Severe Pneumonia in Under-Five Children. Indian J Pediatr. 2018 Jan;85(1):20-24. doi: 10.1007/s12098-017-2514-y.
  4. Gothankar J, Doke P, Dhumale G, Pore P, Lalwani S, Quraishi S, Murarkar S, Patil R, Waghachavare V, Dhobale R, Rasote K, Palkar S, Malshe N. Reported incidence and risk factors of childhood pneumonia in India: a community-based cross-sectional study. BMC Public Health. 2018 Sep 11;18(1):1111. doi: 10.1186/s12889-018-5996-2.
  5. Sutriana VN, Sitaresmi MN, Wahab A. Risk factors for childhood pneumonia: a case-control study in a high prevalence area in Indonesia. Clin Exp Pediatr. 2021 Nov;64(11):588-595. doi: 10.3345/cep.2020.00339.
  6. Kirolos A, Blacow RM, Parajuli A, Welton NJ, Khanna A, Allen SJ, McAllister DA, Campbell H, Nair H. The impact of childhood malnutrition on mortality from pneumonia: a systematic review and network meta-analysis. BMJ Glob Health. 2021 Nov;6(11):e007411. doi: 10.1136/bmjgh-2021-007411.
  7. Chen L, Miao C, Chen Y, Han X, Lin Z, Ye H, Wang C, Zhang H, Li J, Tang Q, Dong Y, Bai M, Zhu Y, Liu G. Age-specific risk factors of severe pneumonia among pediatric patients hospitalized with community-acquired pneumonia. Ital J Pediatr. 2021 Apr 23; 47(1):100. doi: 10.1186/s13052-021-01042-3.
  8. Nasrin S, Tariqujjaman M, Sultana M, Zaman RA, Ali S, Chisti MJ, Faruque ASG, Ahmed T, Fuchs GJ, Gyr N, Alam NH. Factors associated with community acquired severe pneumonia among under five children in Dhaka, Bangladesh: A case control analysis. PLoS One. 2022 Mar 23;17(3):e0265871. doi: 10.1371/journal.pone.0265871.
  9. Wanyana MW, Migisha R, King P, Muhesi AK, Kwesiga B, Kadobera D, Bulage L, Ario AR. Factors associated with severe pneumonia among children <5 years, Kasese District, Uganda: a case-control study, January-April 2023. Pneumonia (Nathan). 2024 Jul 25; 16(1):13. doi: 10.1186/s41479-024-00134-y.
  10. Gamal Y, Mahmoud AO, Mohamed SAA, I Mohamed J, Raheem YFA. Prevalence and impact of malnutrition on outcomes and mortality of under-five years children with pneumonia: a study from Upper Egypt. Eur J Pediatr. 2023 Oct;182(10):4583-4593. doi: 10.1007/s00431-023-05138-2.