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Evaluation of nutritional status and its impact on pulmonary infections in pediatric patients: A hospital-based prospective observational study.

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Abstract

Background:

Pulmonary infections remain a leading cause of pediatric morbidity and hospitalization in low- and middle-income settings, and undernutrition amplifies susceptibility to severe disease and complications.

Objectives:

To evaluate the nutritional status of children admitted with pulmonary infections and to examine its association with infection patterns and short-term clinical outcomes.

Methods:

A hospital-based observational study was conducted in one hundred children aged 1–14 years presenting with clinically diagnosed pulmonary infections. Anthropometry was recorded at admission, and nutritional status was categorized using age-appropriate indices. Pulmonary infection type and severity indicators (severe infection, duration of hospitalization, need for intravenous therapy, and complications) were documented. Group comparisons between children with normal nutrition and undernutrition were performed.

Results:

The mean age was 6.4 ± 3.1 years, and 56% were boys. Undernutrition was present in 58% of children, including mild, moderate, and severe undernutrition in 18%, 26%, and 14%, respectively. Pneumonia was the most common infection pattern, observed in 52% of cases, followed by bronchopneumonia in 28% and recurrent lower respiratory tract infection in 14%. The distribution of infection type did not show a statistically significant association with nutritional status (χ^2=3.99, df=3, p=0.263). However, severe infection was significantly more frequent among undernourished children than normally nourished children (55.2% vs 23.8%; χ^2=9.84, df=1, p=0.002). Complications were also higher in the undernourished group (34.5% vs 14.3%; χ^2=5.16, df=1, p=0.023). Mean hospital stay was significantly longer among undernourished children (7.1 ± 2.4 vs 4.2 ± 1.6 days; t=6.81, p<0.001).

Conclusion:

Undernutrition was common among children hospitalized with pulmonary infections and was significantly associated with greater clinical severity, higher complication burden, and prolonged hospitalization.

Recommendations:

Early nutritional screening and targeted nutritional support should be integrated into routine pediatric respiratory care pathways.

Keywords: *Pediatric; undernutrition; pneumonia; bronchopneumonia; lower respiratory tract infection; hospitalization.*
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Introduction

Pulmonary infections constitute a substantial share of preventable illness in childhood and continue to drive high outpatient attendance, emergency visits, and inpatient admissions. Community-acquired pneumonia and other lower respiratory tract infections (LRTIs) remain prominent causes of disease burden in children and also contribute to morbidity in older age groups [1–3]. The clinical spectrum ranges from self-limited bronchitis to severe pneumonia complicated by hypoxemia, sepsis, or respiratory failure, resulting in high resource utilization and prolonged recovery. Seasonal surges and household crowding further intensify transmission.

Malnutrition and infection form a bidirectional, self-perpetuating cycle. Inadequate dietary intake and nutrient deficiencies weaken innate and adaptive immunity, impair mucosal barrier integrity, and reduce respiratory muscle strength, thereby increasing susceptibility to infections and poor clinical recovery. Conversely, acute infections aggravate catabolism, reduce appetite, and worsen micronutrient depletion, culminating in growth faltering. Global analyses indicate that undernutrition contributes substantially to child deaths from common infectious diseases, including pneumonia [4,5]. Risk increases with greater malnutrition severity, which supports the clinical value of nutrition-based risk stratification at admission [4].

In India, undernutrition remains a persistent public health challenge, particularly among children from socioeconomically disadvantaged households. Tertiary-care hospitals frequently encounter children presenting late in the illness course, often with growth failure and recurrent respiratory infections. Multicenter Indian evidence shows that anthropometric deficits such as low weight-for-height are independent predictors of pneumonia and severe pneumonia, underscoring the role of nutrition as a modifiable risk factor [6]. These observations highlight the need to embed nutrition-focused evaluation within pediatric respiratory care pathways.

Hospital-based studies that connect nutritional status at admission with short-term outcomes can directly inform clinical protocols. Standardized assessment using the WHO Child Growth Standards provides uniform classification across ages and allows reproducible grading of severity [7,8]. Undernutrition has also been linked to prolonged hospital stay and higher inpatient complication burden, thereby increasing healthcare costs and caregiver disruption [9,10]. Despite this, nutrition screening is inconsistently integrated into routine respiratory admissions, and documentation of its association with outcomes is limited in many tertiary settings.

In this context, the present study evaluated nutritional status in pediatric patients admitted with pulmonary infections at a tertiary care teaching hospital in Telangana and examined its relationship with infection pattern, severity markers, and immediate outcomes. The objectives of this study were (i) to describe the distribution of nutritional status among children with pulmonary infections, and (ii) to assess the association between undernutrition and severity indicators, including complications and duration of hospital stay.

Materials and Methods

Study design and setting

This hospital-based prospective observational analytical study was conducted in the Department of Pediatrics, ESIC Medical College and Hospital, Hyderabad, Telangana, India, from January 2025 to August 2025. The nutritional status of eligible children was assessed at the time of admission, and short-term clinical outcomes were prospectively documented during hospitalization. The hospital is a tertiary care teaching and referral centre that provides emergency and inpatient pediatric services to children from urban and peri-urban areas of Hyderabad and surrounding regions.

Study population and eligibility criteria

Children aged 1–14 years admitted with a clinical diagnosis of pulmonary infection, including pneumonia, bronchopneumonia, recurrent lower respiratory tract infection, or other acute respiratory infections requiring inpatient care, were included. Children with chronic lung disease, congenital heart disease with pulmonary overcirculation, chronic renal or hepatic disease, known immunodeficiency, or long-term systemic steroid therapy were excluded, as these conditions could independently influence nutritional status and infection severity.

Study size

The study size was calculated using the single-proportion formula:

$n = Z^2pq / d^2$

where n is the required sample size, Z is the standard normal value at 95% confidence level, p is the expected prevalence of undernutrition among children with pulmonary infections, $q = 1 - p$, and d is the absolute precision.

As local prevalence data were limited, an expected prevalence of 50% was used to obtain the maximum

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required sample size. With 95% confidence level and 10% absolute precision:

$n = (1.96)^2 \times 0.50 \times 0.50 / (0.10)^2$

$n = 3.84 \times 0.25 / 0.01$

$n = 96.04$

Thus, the minimum required sample size was approximately 96 children. This was rounded to 100 children for better feasibility, completeness of analysis, and to compensate for any minor data incompleteness. Therefore, 100 consecutive eligible children were included in the study.

Bias

Several measures were adopted to minimize potential sources of bias. Selection bias was reduced by enrolling consecutive eligible children admitted during the study period. Information bias was minimized by using a structured data collection proforma and predefined operational definitions for pulmonary infection type, severe infection, complications, and hospitalization duration. Measurement bias in anthropometry was limited by using standardized techniques, calibrated weighing scales, and trained staff for height/length and weight assessment. Classification bias was reduced by categorizing nutritional status using age-appropriate WHO growth references. Confounding was addressed at the design stage by excluding children with chronic systemic diseases, immunodeficiency, congenital heart disease, chronic lung disease, or long-term steroid use, as these factors could independently affect both nutritional status and infection outcomes. However, residual confounding due to factors such as immunization status, feeding practices, indoor air pollution, and delayed healthcare-seeking could not be fully eliminated.

Data collection and measurements

After obtaining written informed consent from parents or guardians, demographic details, including age and sex, were recorded using a structured proforma. Clinical information such as presenting symptoms, respiratory signs, working diagnosis, oxygen requirement, intravenous therapy, complications, and duration of hospitalization was documented from clinical examination and hospital records. Anthropometric measurements were obtained at admission by trained staff using standardized methods. Weight was measured using a calibrated digital weighing scale, and height or length was measured using a stadiometer or infantometer, as appropriate for age. Body mass index was calculated as weight in kilograms divided by height in metres squared. Nutritional status was categorized using age-appropriate WHO growth references. Pulmonary infection type and short-term clinical outcomes were recorded during the inpatient stay.

Statistical analysis

Data were entered into a spreadsheet and analyzed using standard statistical software. Categorical variables were summarized as frequency and percentage, and continuous variables as mean ± standard deviation (SD). Associations between nutritional status groups (normal vs undernourished) and categorical outcomes were examined using the chi-square test. An independent sample t-test was applied to compare the mean duration of hospitalization between groups. A p-value <0.05 was considered statistically significant.

Ethical considerations

The study protocol was approved by the Institutional Ethics Committee of ESIC Medical College, Hyderabad. Participation was voluntary, confidentiality was maintained, and clinical management followed institutional protocols aligned with WHO evidence-based guidance and IMCI principles for childhood pneumonia care [11,12].

Results

Participant flow

During the study period, 124 children admitted with suspected pulmonary infections were identified as potentially eligible. Of these, 118 children were examined for eligibility after initial clinical assessment. Eighteen children were excluded: 5 had chronic lung disease, 4 had congenital heart disease with pulmonary overcirculation, 3 had incomplete clinical or anthropometric data, 2 had chronic renal or hepatic disease, 2 had known immunodeficiency, and 2 were receiving long-term systemic steroid therapy. The remaining 100 children fulfilled the eligibility criteria, were enrolled in the study, and were included in the final statistical analysis. No enrolled participant was excluded from the final analysis (Figure 1).

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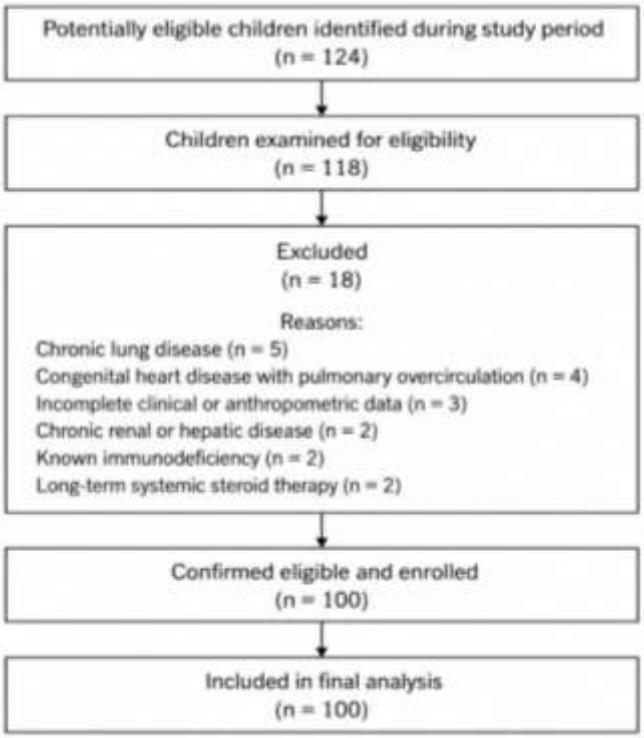

Figure 1. Participant flow diagram of children included in the study

A total of 100 pediatric patients admitted with pulmonary infections were included in the final analysis. The mean age of the study population was 6.4 ± 3.1 years. Children aged 1–5 years constituted the largest subgroup (42%), followed by those aged 6–10 years (38%). Boys accounted for 56% of the cohort (Table 1).

Table 1. Demographic profile of study participants (N = 100)

Variable	Number (%)
Age group (years)	
1–5	42 (42.0)
6–10	38 (38.0)
11–14	20 (20.0)
Sex	
Male	56 (56.0)
Female	44 (44.0)

On anthropometric evaluation, 58% of children were classified as undernourished. Moderate undernutrition was the most frequent category (26%), followed by mild undernutrition (18%) and severe undernutrition (14%). Normal nutritional status was observed in 42% of the children at presentation (Table 2).

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Table 2. Nutritional status distribution among children with pulmonary infections (N = 100)

Nutritional status	Number (%)
Normal nutrition	42 (42.0)
Mild undernutrition	18 (18.0)
Moderate undernutrition	26 (26.0)
Severe undernutrition	14 (14.0)
Total	100 (100.0)

Pneumonia was the predominant diagnosis (52.0%), with a higher proportion among undernourished children than those with normal nutrition (58.6% vs 42.9%). Bronchopneumonia accounted for 28.0% of admissions, followed by recurrent LRTI (14.0%). Other pulmonary infections constituted 6.0% of cases (Table 3).

Table 3. Type of pulmonary infections in relation to nutritional status

Type of infection	**Normal nutrition n (%) (n=42)**	**Undernourished n (%) (n=58)**	**Total n (%) (N=100)**
Pneumonia	18 (42.9)	34 (58.6)	52 (52.0)
Bronchopneumonia	12 (28.6)	16 (27.6)	28 (28.0)
Recurrent LRTI	8 (19.0)	6 (10.3)	14 (14.0)
Others	4 (9.5)	2 (3.4)	6 (6.0)
Total	**42 (100.0)**	**58 (100.0)**	**100 (100.0)**

Pearson's Chi-square test showed no statistically significant association between nutritional status and type of pulmonary infection ($\chi^2 = 3.99$, df = 3, p = 0.263).

Clinical outcomes differed significantly by nutritional status. Severe infections were more frequent among undernourished children (55.2%) than among children with normal nutrition (23.8%) (p<0.01). The mean duration of hospitalization was significantly longer in the undernourished group (7.1 ± 2.4 days) compared with the normal nutrition group (4.2 ± 1.6 days) (p<0.001). Complications occurred more often in undernourished children (34.5% vs 14.3%, p=0.02) (Table 4).

Table 4. Clinical outcomes according to nutritional status

Outcome parameter	Normal nutrition (n = 42)	Undernourished (n = 58)	Test value	p value
Severe infection, n (%)	10 (23.8)	32 (55.2)	$\chi^2 = 9.84$	<0.01
Hospital stay (days), mean ± SD	4.2 ± 1.6	7.1 ± 2.4	t = 6.81	<0.001
Complications, n (%)	6 (14.3)	20 (34.5)	$\chi^2 = 5.16$	0.02

Associations between nutritional status groups and categorical variables were examined using Pearson's Chi-square test. The distribution of pulmonary infection types did not differ significantly between children with normal nutrition and undernutrition ($\chi^2 = 3.99$, df = 3, p = 0.263). Severe infection was significantly associated with undernutrition ($\chi^2 = 9.84$, df = 1, p = 0.002). Similarly, complications were significantly more frequent among undernourished children than normally nourished children ($\chi^2 = 5.16$, df = 1, p = 0.023). Mean duration of hospitalization was compared using an independent-samples t-test and was significantly longer in the undernourished group (t = 6.81, p < 0.001).

Discussion

In this hospital-based study of children admitted with pulmonary infections, undernutrition was highly prevalent, affecting more than half of the cohort. This finding is clinically important because childhood malnutrition is a major determinant of infection susceptibility and severity, particularly for pneumonia in low- and middle-income countries [4,5]. The concentration of admissions in younger age groups is consistent with global patterns showing that early childhood contributes disproportionately to severe LRTI hospitalizations [2,3].

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Pneumonia represented the most common clinical diagnosis, followed by bronchopneumonia and recurrent LRTI. This distribution mirrors published epidemiology in which pneumonia remains a leading cause of pediatric inpatient respiratory morbidity [1–3]. A higher proportion of pneumonia among undernourished children supports the biological plausibility that nutritional deficits increase vulnerability to lower respiratory tract disease. Indian multicenter evidence similarly reports undernutrition as an independent risk factor for both pneumonia and severe pneumonia [6].

A key observation of the present study was the significant association between undernutrition and adverse short-term clinical outcomes. Severe infection was observed in 32 of 58 undernourished children compared with 10 of 42 children with normal nutritional status, showing a significantly higher severity burden among undernourished children [55.2% vs 23.8%; $\chi^2 = 9.84$, df = 1, $p = 0.002$]. Similarly, in-hospital complications were more frequent in the undernourished group than in the normal nutrition group [34.5% vs 14.3%; $\chi^2 = 5.16$, df = 1, $p = 0.023$]. The mean duration of hospitalization was also significantly prolonged among undernourished children [7.1 ± 2.4 days vs 4.2 ± 1.6 days; $t = 6.81$, $p < 0.001$]. These findings indicate that undernutrition was not merely a background clinical characteristic but an important marker of disease severity, complication risk, and delayed recovery among children hospitalized with pulmonary infections. The observed pattern is biologically plausible, as nutritional deficits may impair immune response, weaken respiratory muscle function, and reduce physiological reserve during acute infection. These results are consistent with previous clinical evidence showing that malnutrition increases the burden of pediatric respiratory illness and contributes to longer inpatient care requirements [9,10].

These findings align with clinical literature demonstrating that malnutrition prolongs recovery and increases inpatient burden [9,10]. Topal and Tolunay observed a graded rise in length of stay with increasing malnutrition severity, suggesting that nutrition risk has tangible operational consequences in pediatric wards [9].

Operationally, longer hospital stay and complications in undernourished children imply greater demand for oxygen therapy, intravenous antibiotics, and close monitoring. Routine anthropometric screening at admission using WHO growth references offers a practical approach to identify high-risk children and trigger timely nutrition support [7,8]. Combining nutrition interventions with standardized pneumonia management pathways improves coherence of care, particularly in tertiary referral settings where severe presentations are frequent [11,12].

From a preventive standpoint, the high proportion of undernutrition among children hospitalized for pulmonary infections suggests missed opportunities for earlier community-based identification and intervention. Recent prospective observations have linked undernutrition with persistent or prolonged pneumonia courses, reinforcing the need for post-discharge follow-up and growth rehabilitation [13]. Further, delayed recovery in severe pneumonia has been associated with baseline nutritional risk factors, supporting the integration of nutrition optimization into comprehensive respiratory management [14].

Generalizability: The study reflects routine inpatient practice in a tertiary care teaching hospital serving predominantly lower socioeconomic populations in an urban–peri-urban region of Telangana. These findings apply to similar referral settings in India where undernutrition remains common, and pneumonia contributes substantially to admissions. Extrapolation to primary care settings should consider differences in early access to antibiotics, referral thresholds, and community nutrition program coverage. Multicenter studies can refine estimates across diverse casemix patterns.

Conclusion

Undernutrition was common among children hospitalized with pulmonary infections at a tertiary care center in Telangana and demonstrated a clear association with disease severity. Children with undernutrition experienced higher proportions of severe infections and complications, along with a significantly longer duration of hospitalization compared with children having a normal nutritional status. These results emphasize that nutritional assessment should be an essential component of pediatric respiratory case management rather than an adjunct observation. Routine anthropometric screening at admission, early nutrition support, and structured follow-up after discharge can strengthen recovery trajectories, reduce recurrent infections, and improve overall child health outcomes in resource-limited settings. Incorporating nutrition targets into routine inpatient monitoring can support measurable improvement.

Limitations

This single-center hospital-based study included only admitted children, which limits the representation of milder community-managed infections. Nutritional status was assessed at admission and did not capture longitudinal changes during hospitalization or after discharge. Microbiological confirmation of etiology and detailed micronutrient profiling were not performed, restricting analysis of pathogen-specific effects and specific

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deficiencies. Potential confounders such as immunization status, household air pollution exposure, and breastfeeding history were not analyzed in depth.

Recommendations

All pediatric admissions with respiratory infections should undergo standardized nutrition risk screening at triage using WHO growth references. Children identified with undernutrition require early dietitian referral, energy-dense therapeutic feeds, and monitoring of weight gain during hospitalization. Discharge plans should include caregiver counseling on age-appropriate balanced diets, hydration, and recognition of danger signs warranting early review. Linkages with immunization services, anemia screening, and community nutrition programs should be strengthened to prevent recurrence, promote catch-up growth, and reduce avoidable readmissions and caregiver economic loss. Hospital teams should also audit antibiotic use, consider micronutrient supplementation when indicated, and provide take-home diet charts in the local language.

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Abbreviations

BMI: Body mass index
LRTI: Lower respiratory tract infection
SD: Standard deviation
WHO: World Health Organization
IMCI: Integrated Management of Childhood Illness
ESIC: Employees' State Insurance Corporation

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The study has no funding

Conflict of interest

The author declares no conflict of interest.

Author contributions

VSS-Concept and design of the study, results interpretation, review of literature, and preparation of the first draft of the manuscript. Statistical analysis and interpretation, revision of manuscript. **SC**- Design of the study, results interpretation, review of literature, and preparing the first draft of the manuscript, revision of the manuscript. **SSK**-results interpretation, review of literature, and preparing the first draft of the manuscript, and revision of the manuscript.

Data availability

Data available on request

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