SJ Pediatrics and Child Health Africa
Vol. 3 No. 2 (2026): May 2026 Issue
https://doi.org/10.51168/wgaz2j03
Original Article

Association between Nutritional Status and Frequency of Respiratory Tract Infections in Children Under Five Years: A Prospective Cohort Study.

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Abstract

Background:

Respiratory tract infections are a major cause of morbidity in children under five years, and undernutrition may increase susceptibility by impairing immune defence.

Objectives:

To assess the association between nutritional status and the frequency of respiratory tract infections among children under five years.

Methods:

This hospital-based prospective cohort study was conducted in the Department of Paediatrics at Dr. Pinnamaneni Siddhartha Institute of Medical Sciences & Research Foundation, Andhra Pradesh, from March to August 2025. One hundred consecutive eligible children were enrolled. Nutritional status was assessed using World Health Organization growth standards and categorized as normal, mild-to-moderate undernutrition, or severe undernutrition. Respiratory tract infection episodes were prospectively documented; frequent infection was defined as three or more episodes. Pearson's chi-square test and one-way analysis of variance were used.

Results:

The mean age was 31.6 ± 14.2 months, and 56.0% were male. Nutritional status was normal in 52.0%, mild-to-moderate undernutrition in 34.0%, and severe undernutrition in 14.0%. Frequent respiratory tract infections occurred in 39.0%. Their frequency increased from 15.4% in normally nourished children to 55.9% and 85.7% in the mild-to-moderate and severe undernutrition groups, respectively ($\chi^2(2) = 29.11$, $p < 0.001$). Mean infection episodes also increased across these groups (1.6 ± 0.9, 2.7 ± 1.1, and 4.1 ± 1.3; $F(2, 97) = 35.82$, $p < 0.001$). Underweight ($\chi^2(1) = 15.04$), wasting ($\chi^2(1) = 15.30$), and stunting ($\chi^2(1) = 15.60$) were each associated with frequent infection (all $p < 0.001$).

Conclusion:

Poorer nutritional status was strongly associated with more frequent respiratory tract infections.

Recommendations:

Nutritional screening, growth monitoring, breastfeeding support, immunization review, and early dietary counselling should be integrated into routine paediatric care.

Keywords: *Nutritional status; Undernutrition; Respiratory tract infection; Under-five children; Wasting; Stunting; Prospective cohort study.*
Submitted: *March 20, 2026* ***Accepted:*** *April 30, 2026* ***Published:*** *May 30, 2026*
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Introduction

Respiratory tract infections are among the most frequent causes of illness in children under five years and continue to contribute substantially to paediatric outpatient visits, antibiotic use, school or day-care absence, hospitalization, and preventable mortality. Acute lower respiratory infections are especially important in young children because rapid deterioration can occur in the presence of delayed care, poor immunity, and coexisting nutritional deficits. The burden is higher in low- and middle-income settings, where environmental exposure, household

crowding, low health literacy, and limited access to timely health services interact with biological vulnerability [1].

Childhood undernutrition remains a persistent public health concern. It includes underweight, wasting, stunting, and micronutrient deficiencies, each reflecting a different aspect of inadequate nutrition and growth failure. Global analyses have shown that undernutrition contributes to childhood morbidity and mortality through both direct and indirect pathways. It weakens physical barriers, mucosal integrity, innate immune response, and adaptive immune mechanisms, thereby increasing both the frequency and severity of common infections [2,3]. Infections also reduce appetite, increase metabolic demand, impair nutrient absorption, and promote further growth faltering. This bidirectional relationship creates a clinically important cycle in which undernutrition predisposes to infection and infection aggravates undernutrition [4,5].

Anthropometric assessment is an accessible and reproducible method for identifying children at risk. Weight-for-age, weight-for-height or weight-for-length, and height-for-age indicators help classify underweight, wasting, and stunting according to standard growth references. These measurements are useful not only for nutritional diagnosis but also for anticipating infection risk and prioritizing counselling, follow-up, and referral. The WHO Child Growth Standards provide a widely accepted framework for interpreting growth in children below five years and support uniform comparison across clinical and public health settings [6,7].

Infant and young child feeding practices also influence respiratory morbidity. Exclusive breastfeeding during the first six months provides immunological protection through secretory immunoglobulin A, lactoferrin, oligosaccharides, immune cells, and anti-inflammatory factors. Longer breastfeeding duration has been associated with reduced respiratory illness and hospitalization in several paediatric studies [8-10]. Similarly, incomplete immunization, socioeconomic disadvantage, and delayed care seeking increase vulnerability to respiratory infections. Therefore, the relationship between nutritional status and respiratory tract infections needs evaluation within the broader child health context rather than as an isolated biological association.

The present study was planned to evaluate this association in children under five years attending a tertiary care teaching hospital in Andhra Pradesh. The primary objective was to assess the association between nutritional status and frequency of respiratory tract infections. The secondary objectives were to describe the nutritional profile of the study children, document the pattern of respiratory tract infections during follow-up, and examine the association of underweight, wasting, and stunting with frequent respiratory tract infections.

Methodology

Study design and setting

This hospital-based prospective cohort study was conducted in the Department of Paediatrics at Dr. Pinnamaneni Siddhartha Institute of Medical Sciences & Research Foundation, Chinna Avutapalli, Gannavaram, Vijayawada, Andhra Pradesh, India, from March 2025 to August 2025. The institute is a multispecialty tertiary care teaching centre serving rural and semi-urban communities around Gannavaram and Vijayawada. Its teaching hospital provides outpatient, inpatient, emergency, critical care, laboratory, imaging, and multidisciplinary referral services. The prospective cohort design enabled documentation of baseline nutritional status followed by subsequent respiratory infection episodes without assigning an intervention. Reporting followed accepted guidance for observational studies [11].

Study population and eligibility criteria

Children below five years attending paediatric outpatient or inpatient services were considered for enrolment. Children were included when the parent or guardian provided informed consent and anthropometric assessment was completed. Children with congenital heart disease, chronic lung disease, primary immunodeficiency, long-term corticosteroid therapy, active tuberculosis, or incomplete follow-up data were excluded. Children requiring emergency stabilization were enrolled only after clinical stabilization and consent.

Sample size and sampling technique

The sample size was calculated for estimating a single proportion using the formula $n = Z^2p(1 - p)/d^2$. At a 95% confidence level ($Z = 1.96$), an anticipated proportion of 50% was selected to provide the maximum variance in the absence of a precise local estimate, and an absolute precision of 10% was used. The calculated sample size was 96.04; the minimum requirement was rounded up, and a final target of 100 children was adopted. Consecutive eligible children were recruited in the order of attendance until the target sample was reached. Each enrolled child was followed prospectively for documentation of respiratory tract infection episodes.

Study variables and operational definitions

The primary outcome was frequent respiratory tract infection, defined as three or more clinically documented episodes during follow-up. The main exposure variable was nutritional status. Weight, length or height, and age were recorded and interpreted using WHO child growth standards [6,7]. Children were categorized as normal nutritional status, mild-to-moderate undernutrition, or severe undernutrition. Underweight, wasting, and stunting were

also recorded. Other variables included age, sex, socioeconomic status, immunization status, exclusive breastfeeding for six months, infection type, and hospital admission.

Data collection procedure

Data were collected using a structured case record form. Demographic details, feeding history, immunization status, socioeconomic status, and clinical history were obtained from caregiver interviews and medical records. Weight was measured with a calibrated weighing scale, while length or height was measured using age-appropriate equipment. Respiratory tract infections were diagnosed by the treating paediatrician and categorized as upper or lower respiratory tract infections using symptoms, examination findings, and treatment records.

Bias control and statistical analysis

Standardized anthropometric procedures and uniform operational definitions were used. Consecutive sampling reduced selective enrolment, and prospective recording reduced recall error. Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean and standard deviation. Pearson's chi-square test was used to assess associations between categorical variables because expected cell counts were adequate. Mean respiratory tract infection episodes across the three nutritional groups were compared using one-way analysis of variance. Test statistics, degrees of freedom, and exact or threshold p values were reported. All tests were two-tailed, and $p < 0.05$ was considered statistically significant.

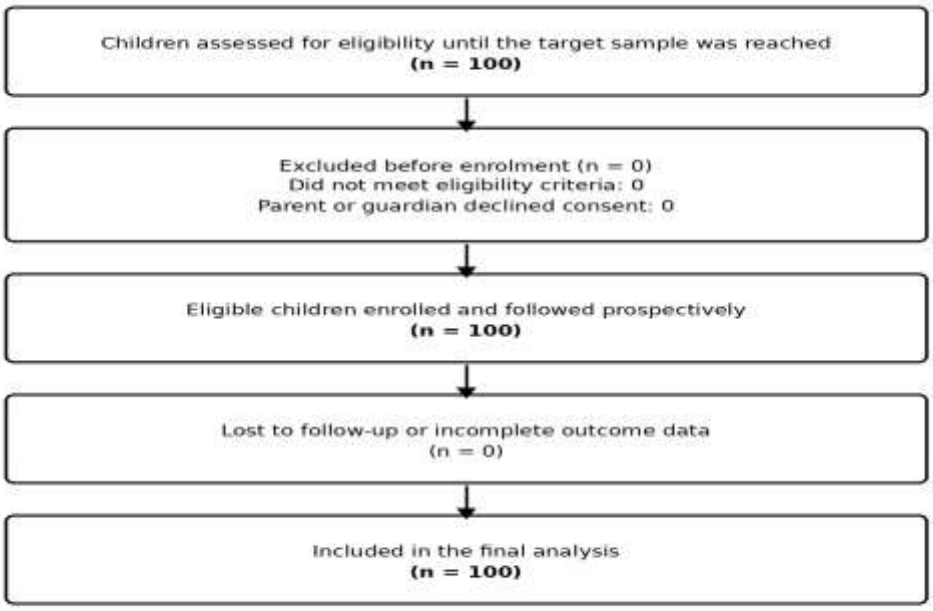
Ethical consideration

Institutional Ethics Committee approval was obtained from Dr. Pinnamaneni Siddhartha Institute of Medical Sciences & Research Foundation, Chinna Avutapalli, Gannavaram, Vijayawada, Andhra Pradesh, India, before the study. Written informed consent was obtained from parents or legally acceptable guardians. Participation did not alter routine care. Children received standard treatment according to clinical need. Personal identifiers were removed before analysis, and confidentiality was maintained throughout the study.

Results

Participant flow: Consecutive children were screened until the target sample was reached. All 100 children assessed met the eligibility criteria, parental or guardian consent was obtained, no child was lost to follow-up, and all 100 participants were included in the final analysis.

Figure 1: ***Participant flow diagram***



A total of 100 children under five years of age were included in the final analysis. The mean age of the study participants was 31.6 ± 14.2 months. The largest proportion of children belonged to the 36-59 months age group. Males constituted 56 children (56.0%), while females accounted for 44 children (44.0%). Low socioeconomic status was documented in 58 children (58.0%), and incomplete immunization for age was observed in 21 children (21.0%).

Exclusive breastfeeding for the first six months was reported in 61 children (61.0%) (Table 1).

Table 1: ***Baseline characteristics of the study participants (N = 100)***

Variable	Frequency	Percentage
Age group		
<12 months	18	18.0
12-23 months	27	27.0
24-35 months	24	24.0
36-59 months	31	31.0
Sex		
Male	56	56.0
Female	44	44.0
Socioeconomic status		
Low	58	58.0
Middle	34	34.0
High	8	8.0
Immunization status		
Complete for age	79	79.0
Incomplete for age	21	21.0
Exclusive breastfeeding for 6 months		
Yes	61	61.0
No	39	39.0

Based on nutritional assessment, 52 children (52.0%) had normal nutritional status, while 34 children (34.0%) had mild-to-moderate undernutrition and 14 children (14.0%) had severe undernutrition. Underweight was observed in 38 children (38.0%), wasting in 27 children (27.0%), and stunting in 31 children (31.0%) (Table 2).

Table 2: ***Nutritional profile of the study participants (N = 100)***

Nutritional parameter	Frequency	Percentage
Overall nutritional status		
Normal nutritional status	52	52.0
Mild-to-moderate undernutrition	34	34.0
Severe undernutrition	14	14.0
Underweight		
Present	38	38.0
Absent	62	62.0
Wasting		
Present	27	27.0
Absent	73	73.0
Stunting		
Present	31	31.0
Absent	69	69.0

During the follow-up period, 39 children (39.0%) developed frequent respiratory tract infections, defined as three or more episodes. The mean number of respiratory tract infection episodes was 2.4 ± 1.4 per child. Upper respiratory tract infections were more common than lower respiratory tract infections. Hospital admission due to respiratory infection was required in 13 children (13.0%) (Table 3).

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Original Article

Table 3: ***Frequency and pattern of respiratory tract infections among children (N = 100)***

Variable	Frequency	Percentage
Number of RTI episodes		
0-1 episode	29	29.0
2 episodes	32	32.0
>=3 episodes	39	39.0
Type of RTI predominantly observed		
Upper respiratory tract infection	67	67.0
Lower respiratory tract infection	33	33.0
Hospital admission due to RTI		
Required	13	13.0
Not required	87	87.0

A clear graded association was observed between poorer nutritional status and frequent respiratory tract infections. Frequent infections occurred in 8 of 52 children (15.4%) with normal nutritional status, 19 of 34 (55.9%) with mild-to-moderate undernutrition, and 12 of 14 (85.7%) with severe undernutrition. The association was statistically significant (Pearson $\chi^2(2) = 29.11$, $p < 0.001$). Mean respiratory tract infection episodes also increased progressively across the three nutritional groups, from 1.6 ± 0.9 to 2.7 ± 1.1 and 4.1 ± 1.3 episodes, respectively (one-way analysis of variance, $F(2, 97) = 35.82$, $p < 0.001$) (Table 4).

Table 4: ***Association between nutritional status and frequency of respiratory tract infections***

Nutritional status	Total children	Frequent RTI, n (%)	Mean RTI episodes	p value
Normal nutritional status	52	8 (15.4)	1.6 ± 0.9	
Mild-to-moderate undernutrition	34	19 (55.9)	2.7 ± 1.1	<0.001
Severe undernutrition	14	12 (85.7)	4.1 ± 1.3	

Note. Nutritional status versus frequent RTI: Pearson $\chi^2(2) = 29.11$, $p < 0.001$. Mean RTI episodes across nutritional groups: one-way analysis of variance $F(2, 97) = 35.82$, $p < 0.001$. RTI = respiratory tract infection.

Children with underweight, wasting, and stunting had a significantly higher burden of frequent respiratory tract infections than children without these deficits. Frequent infections were documented in 24 of 38 underweight children (63.2%) compared with 15 of 62 children without underweight (24.2%; $\chi^2(1) = 15.04$, $p < 0.001$). Corresponding proportions were 19 of 27 (70.4%) versus 20 of 73 (27.4%) for wasting ($\chi^2(1) = 15.30$, $p < 0.001$), and 21 of 31 (67.7%) versus 18 of 69 (26.1%) for stunting ($\chi^2(1) = 15.60$, $p < 0.001$) (Table 5).

Table 5: ***Association of specific nutritional deficits with frequent respiratory tract infections***

Nutritional indicator	Frequent RTI when present, n/N (%)	Frequent RTI when absent, n/N (%)	χ^2 (df = 1)	p value
Underweight	24/38 (63.2)	15/62 (24.2)	15.04	<0.001
Wasting	19/27 (70.4)	20/73 (27.4)	15.30	<0.001
Stunting	21/31 (67.7)	18/69 (26.1)	15.60	<0.001

Note. Values are Pearson chi-square statistics. RTI = respiratory tract infection.

Across the analysed nutritional indicators, frequent respiratory tract infections were consistently more common among children with nutritional deficits. The absolute difference in frequent infection prevalence was 39.0 percentage points for underweight, 43.0 percentage points for wasting, and 41.6 percentage points for stunting.

Discussion

The present prospective cohort study demonstrated a strong graded association between poor nutritional status and frequent respiratory tract infections among children under five years. Frequent infections were observed in 15.4% of normally nourished children, 55.9% of those with mild-to-moderate undernutrition, and 85.7% of those with severe undernutrition ($\chi^2(2) = 29.11$, $p < 0.001$). This dose-response pattern supports the biological plausibility that declining nutritional status increases vulnerability to repeated respiratory morbidity through impaired mucosal integrity and altered innate and adaptive immune responses [4,5].

The mean number of respiratory tract infection episodes increased from 1.6 ± 0.9 in normally nourished children to 4.1 ± 1.3 among those with severe undernutrition, with a significant difference across nutritional groups ($F(2, 97) = 35.82$, $p < 0.001$). This pattern is clinically important because repeated respiratory illness can reduce appetite, increase metabolic demand, disrupt sleep, raise caregiver expenditure, and promote repeated antibiotic exposure. Global child health analyses have identified undernutrition as an active contributor to infection-related morbidity and mortality [2,3], while pneumonia reviews have shown progressively poorer outcomes with increasing malnutrition severity [12].

Specific nutritional deficits showed similarly strong associations. Frequent respiratory tract infections occurred in 63.2% of underweight children, 70.4% of wasted children, and 67.7% of stunted children, with Pearson chi-square values of 15.04, 15.30, and 15.60, respectively (all $p < 0.001$). Wasting reflects acute nutritional compromise, stunting indicates chronic deprivation, and underweight may represent overlapping acute and chronic deficits. These findings agree with studies identifying malnutrition as an important predictor of respiratory infection alongside household, socioeconomic, and caregiver-related factors [1,13]. Anthropometric screening therefore provides a simple method for identifying children who may require closer respiratory follow-up.

Immunization status, exclusive breastfeeding, and socioeconomic status were described in the cohort, but adjusted estimates of their independent effects were not generated in the present analysis. These variables nevertheless remain clinically relevant because breastfeeding has been associated with reduced respiratory morbidity and fewer infection-related hospitalizations [8-10], while socioeconomic disadvantage may increase exposure through crowding, delayed care, limited dietary diversity, and reduced access to preventive services. Future multivariable analyses should examine whether nutritional status retains an independent association after accounting for these potential confounders. Nutritional rehabilitation and dietary counselling may improve growth and reduce recurrent upper respiratory tract infections among nutritionally at-risk children [14].

Generalizability: The findings are most applicable to children under five years attending tertiary paediatric outpatient or inpatient services in rural and semi-urban Andhra Pradesh and to comparable South Indian hospital populations. They may not directly represent community-dwelling children, primary care populations, highly urban referral centres, or regions with different nutritional and respiratory disease profiles. Consecutive recruitment and the consistent biological gradient across nutritional categories support transferability to similar clinical settings; however, multicentre community-based cohorts with longer follow-up and adjusted analyses are required before broader population-level inference.

Conclusion

This prospective cohort study identified a significant graded association between poor nutritional status and frequent respiratory tract infections among children under five years. Children with mild-to-moderate and severe undernutrition experienced progressively greater infection frequency than normally nourished children. Underweight, wasting, and stunting were each associated with frequent respiratory tract infections. Routine anthropometric assessment should therefore be incorporated into the evaluation of children with recurrent respiratory illness. Growth monitoring, dietary counselling, breastfeeding support, immunization review, and early management of nutritional deficits may help reduce respiratory morbidity when integrated into paediatric outpatient, inpatient, and community follow-up services.

Limitations

This was a single-centre hospital-based study with 100 children, limiting population-level inference. Respiratory episodes treated outside the hospital may have been missed despite prospective follow-up. Dietary intake, micronutrient status, indoor air pollution, caregiver education, household crowding, seasonal variation, pathogen profile, prior antibiotic exposure, and day-care attendance were not assessed in detail. The reported associations were unadjusted; therefore, residual confounding and independent effects of related child-health variables could not be evaluated.

Recommendations

Routine nutritional screening should be performed for every child under five years presenting with recurrent respiratory symptoms. Children with underweight, wasting, or stunting require structured dietary counselling, follow-up anthropometry, immunization review, and caregiver education on early danger signs. Exclusive breastfeeding for six months and appropriate complementary feeding should be reinforced through outpatient and community health services. Paediatric units should link recurrent respiratory infection care with nutrition rehabilitation services. Larger

multicentre prospective studies with dietary assessment, environmental exposure data, and longer follow-up are recommended to strengthen causal interpretation and guide locally adapted preventive strategies for South Indian children and similar settings.

Acknowledgement
The authors thank the Department of Paediatrics, nursing staff, participating children, and caregivers for their cooperation during data collection and follow-up. The authors also acknowledge the institutional support provided by Dr. Pinnamaneni Siddhartha Institute of Medical Sciences & Research Foundation during the conduct of the study.

List of abbreviations
RTI: Respiratory tract infection
WHO: World Health Organization

Source of funding
This study received no external funding or financial support.

Conflict of interest
The authors declare that they have no conflicts of interest.

Data availability
De-identified study data are available from the corresponding author upon reasonable request, subject to institutional and ethical requirements for participant confidentiality.

Author contributions
NM: Conceptualization, methodology, supervision, and critical review of the manuscript. **SP**: Investigation, participant assessment, data collection, data curation, and literature review. **YLP**: Formal analysis, interpretation, manuscript drafting, editing, and correspondence.

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