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RELATIONSHIP BETWEEN NUTRITIONAL STATUS AND SEVERITY OF ACUTE RESPIRATORY TRACT INFECTIONS IN CHILDREN

***Dr. Reem Subhi Aziz, Dr. Sura Sami Dawood, Dr. Noor Falih Fadheel**

M.B.Ch.B./ C.A.B.P.

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***Corresponding Author: Dr. Reem Subhi Aziz**

M.B.Ch.B./ C.A.B.P.

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ABSTRACT

Background: Acute respiratory tract infections (ARTIs) are a major cause of morbidity and hospitalization among children. Nutritional status may influence susceptibility to infection and the ability to withstand severe respiratory illness. However, the relationship between nutritional status and the clinical severity of ARTIs remains important to investigate in local pediatric populations. **Objectives:** To assess the relationship between nutritional status and the severity of acute respiratory tract infections among children and to determine whether nutritional abnormalities are associated with increased clinical severity and adverse respiratory manifestations. **Patients and methods:** A hospital-based cross-sectional study was conducted among 121 children with acute respiratory tract infections at Al-Khansaa Teaching Hospital, Nineveh Directorate of Health, Nineveh Governorate, Iraq, from December 2024 to April 2026. Demographic and clinical data were collected, including respiratory rate, oxygen saturation, respiratory distress, chest indrawing, and feeding ability. Nutritional status was assessed using anthropometric measurements and WHO growth standards, including weight-for-age, height-for-age, weight-for-height, BMI-for-age, and MUAC where appropriate. The severity of ARTI was classified according to clinical respiratory findings and danger signs. Statistical analysis was performed using SPSS, with $P<0.05$ considered statistically significant. **Results:** The mean age of the children was 2.7 ± 1.4 years, and 55.4% were males. Cough was the most frequent clinical manifestation (95.0%), followed by fever (84.3%). Normal nutritional status was observed in 51.2% of children, while stunting, underweight, and wasting were present in 24.0%, 19.0%, and 17.4%, respectively. Mild, moderate, and severe ARTI accounted for 43.8%, 37.2%, and 19.0% of cases, respectively. Nutritional status was significantly associated with disease severity ($P<0.001$). Severe disease was observed in 26.1% of underweight children and 33.3% of wasted children compared with 6.5% of children with normal nutritional status. Undernourished children had higher respiratory rates and lower oxygen saturation, with significantly higher frequencies of tachypnea, chest indrawing, oxygen saturation <92%, and poor feeding. Undernutrition was strongly associated with severe ARTI (crude OR=11.12, 95% CI: 4.03–30.66; $P<0.001$) and remained independently associated after adjustment (adjusted OR=7.84, 95% CI: 2.67–23.04; $P<0.001$). Wasting (adjusted OR=2.96, 95% CI: 1.08–8.12; P=0.035) and stunting (adjusted OR=2.41, 95% CI: 1.01–5.77; P=0.048) were also independent predictors of severe disease. The combined nutritional indicators demonstrated moderate discriminatory ability for severe ARTI (AUC=0.801). **Conclusions:** Nutritional status was significantly associated with the severity of acute respiratory tract infections in children. Undernutrition, wasting, and stunting were associated with greater respiratory compromise and independently predicted severe disease. Routine nutritional assessment should therefore be incorporated into the clinical evaluation of children with ARTIs, particularly to identify those requiring closer monitoring and comprehensive supportive care.

KEYWORDS: Acute respiratory tract infections; Anthropometry; Children; Disease severity; Nutritional status; Pneumonia; Stunting; Undernutrition; Wasting.

1-INTRODUCTION

Acute respiratory tract infections are among the most frequent infectious illnesses affecting children and constitute a major cause of morbidity, healthcare utilization, hospitalization, and mortality worldwide. The clinical spectrum ranges from mild upper respiratory tract infections to severe lower respiratory tract infections, particularly pneumonia, which may be complicated by respiratory distress, hypoxemia, sepsis, and death. Pneumonia remains one of the leading infectious causes of mortality among children under five years of age, with the greatest burden occurring in low- and middle-income countries.[1] The high frequency of respiratory infections during childhood makes identification of modifiable factors associated with disease severity an important public-health and clinical priority.

Nutritional status is a major determinant of child health and is closely related to growth, immune competence, resistance to infection, and recovery from illness. Childhood malnutrition encompasses a broad spectrum of nutritional disorders, including wasting, stunting, underweight, micronutrient deficiencies, overweight, and obesity. Undernutrition remains particularly important in developing countries, where inadequate dietary intake, poverty, recurrent infections, poor sanitation, and limited access to healthcare may interact to produce a persistent cycle of malnutrition and disease. Global estimates continue to demonstrate a substantial burden of wasting and stunting among children, particularly in low- and middle-income countries.[2]

The relationship between nutritional status and respiratory infection is complex and bidirectional. Malnutrition can compromise the normal function of both innate and adaptive immunity, thereby increasing susceptibility to infectious diseases. Protein-energy deficiency may impair lymphocyte function, antibody production, complement activity, phagocytic responses, and the integrity of epithelial barriers. Nutritional deficiency may also impair mucociliary clearance and respiratory muscle function, reducing the ability of the respiratory system to eliminate pathogens and secretions.[3] Consequently, children with poor nutritional status may be more susceptible to respiratory infections and may have a greater likelihood of developing severe disease.

Conversely, acute respiratory infections may contribute to deterioration of nutritional status. Fever and systemic inflammation increase metabolic requirements, while anorexia, reduced oral intake, vomiting, and difficulties feeding may decrease energy and nutrient consumption. Severe or recurrent infections may therefore accelerate weight loss and nutritional deterioration. This creates a potentially self-perpetuating cycle in which malnutrition increases susceptibility to infection, while infection further worsens nutritional status.[4] Understanding this interaction is particularly important in children because nutritional requirements are high during periods of rapid growth and development.

The influence of nutritional status on the severity of respiratory infections is supported by epidemiological evidence. Undernutrition has been consistently identified as an important risk factor for severe pneumonia and pneumonia-related mortality in children. A systematic review and network meta-analysis demonstrated a progressive increase in the risk of death from pneumonia with increasing severity of underweight, with severely underweight children having substantially higher mortality than children without severe underweight.[5] These findings suggest that nutritional status may influence not only the likelihood of acquiring respiratory infection but also the clinical outcome once infection occurs.

Severe acute malnutrition is particularly important in relation to respiratory infection because clinical manifestations of serious infection may be altered in severely malnourished children. Impaired inflammatory and immune responses may result in less obvious clinical signs despite substantial disease. This may make early recognition of severe respiratory infection more difficult and potentially delay appropriate treatment.[6] The World Health Organization therefore emphasizes early identification and management of acute malnutrition in children, particularly because severely malnourished children have an increased risk of infection, complications, and mortality.[7]

Several mechanisms may explain why nutritional deficiency contributes to more severe respiratory disease. Malnutrition can alter the structural integrity of the respiratory epithelium, impair alveolar macrophage activity, reduce lymphocyte-mediated immunity, and interfere with antibody and complement responses. Deficiencies of essential micronutrients may additionally influence immune-cell proliferation, antioxidant defenses, and inflammatory regulation.[3,8] These effects may facilitate pathogen invasion, impair pathogen clearance, and increase the likelihood that an initially localized respiratory infection will progress to lower respiratory tract involvement or severe pneumonia.

Micronutrient status may also influence susceptibility to respiratory infections. Iron, zinc, vitamin A, vitamin D, and other micronutrients participate in immune regulation and maintenance of epithelial integrity. Zinc, for example, is involved in numerous enzymatic processes and immune functions, while vitamin A contributes to epithelial maintenance and immune responses. However, the relationship between individual micronutrients and respiratory infection severity is not uniform, and deficiencies may coexist with broader forms of undernutrition. Therefore, assessment of overall nutritional status may provide a more clinically useful measure of vulnerability than evaluation of a single nutrient alone.[8]

Anthropometric assessment provides a practical approach to evaluating nutritional status in children. Weight-for-age, height-for-age, weight-for-height, body mass index-for-age, and mid-upper-arm circumference can be used according to the child's age and clinical circumstances. The WHO Child Growth Standards provide standardized references for assessing growth and nutritional status during childhood and allow identification of wasting, stunting, underweight, and abnormalities of weight relative to height.[9] In children aged under five years, severe wasting and nutritional oedema are particularly important because they are strongly associated with increased morbidity and mortality.

The severity of acute respiratory tract infection can similarly be evaluated using objective clinical parameters. These include respiratory rate, work of breathing, chest indrawing, oxygen saturation, cyanosis, inability to feed or drink, altered consciousness, and other clinical danger signs. Hypoxemia is an important marker of severe respiratory disease and is associated with increased mortality. Current WHO guidance emphasizes prompt recognition of hypoxemia and other indicators of severe pneumonia in children to facilitate timely treatment and supportive care.[10] Combining assessment of nutritional status with standardized assessment of respiratory severity may therefore improve identification of children at increased risk of adverse outcomes.

Importantly, the relationship between nutritional status and respiratory infection severity may vary according to the type and degree of nutritional abnormality. Children with severe wasting may have a particularly high risk of severe infection and death, whereas the relationship between stunting and acute disease severity may be less direct. Stunting reflects chronic nutritional deprivation and may indicate long-standing environmental and socioeconomic disadvantage, while wasting more directly reflects acute or recent nutritional deterioration. Distinguishing these nutritional phenotypes may therefore provide additional insight into their respective relationships with acute respiratory disease.[2,7]

In addition to undernutrition, excessive weight has emerged as an increasingly relevant nutritional problem in children. Childhood overweight and obesity may influence respiratory health through altered respiratory mechanics, chronic low-grade inflammation, and metabolic dysfunction. Although the evidence linking overweight or obesity with severity of acute respiratory infections in children is less consistent than the evidence concerning undernutrition, assessing nutritional status across the full spectrum may provide a more comprehensive understanding of its relationship with respiratory disease.[2,11] This is particularly relevant in populations undergoing nutritional and epidemiological transitions.

The interaction between nutrition and respiratory infection is especially relevant in low- and middle-income settings, where children may be simultaneously exposed to nutritional deficiencies, recurrent infections, overcrowding, indoor air pollution, inadequate sanitation, and limited access to healthcare. These factors may interact and increase the risk of severe respiratory illness. Consequently, nutritional status should be considered within the broader clinical and socioeconomic context when evaluating children with acute respiratory tract infections.

Despite extensive evidence demonstrating an association between malnutrition and childhood infections, important questions remain regarding the relationship between the degree of nutritional abnormality and the clinical severity of acute respiratory tract infections. Many previous investigations have focused specifically on severe acute malnutrition, pneumonia mortality, or individual micronutrient deficiencies, whereas fewer studies have evaluated nutritional status across different categories and examined its relationship with multiple indicators of respiratory disease severity. Furthermore, differences in age distribution, nutritional patterns, infectious etiologies, socioeconomic conditions, and healthcare access may result in substantial variation between populations.[5,8] Therefore, assessment of nutritional status among children presenting with acute respiratory tract infections may provide clinically valuable information for identifying those at greater risk of severe disease. Establishing such an association could support early nutritional screening, closer monitoring, timely intervention, and appropriate nutritional management as part of comprehensive pediatric respiratory care. It may also contribute to the development of locally relevant strategies aimed at reducing respiratory morbidity and mortality among children.

2-PATIENTS AND METHODS

This study was designed as a hospital-based cross-sectional study to investigate the relationship between nutritional status and the clinical severity of acute respiratory tract infections among children. The study was conducted at Al-Khansaa Teaching Hospital, Nineveh Directorate of Health, Nineveh Governorate, Iraq, over a period extending from December 2024 to April 2026. A total of 121 children diagnosed with acute respiratory tract infections and presenting to the hospital during the study period were enrolled.

Children were eligible for inclusion when they presented with an acute respiratory tract infection, as determined by the clinical history and physical examination. The study population included children within the predefined pediatric age range who had symptoms and clinical findings suggestive of acute respiratory tract infection. Children with chronic respiratory or systemic diseases that could independently affect nutritional status or the severity of respiratory illness were excluded, together with children with conditions that could interfere with accurate anthropometric assessment or clinical evaluation, where applicable.

For each enrolled child, a structured assessment was performed. Demographic information including age, sex, and residence was recorded. A detailed history was obtained regarding the presenting illness, including duration of fever, cough, nasal discharge, difficulty in breathing, wheezing, poor feeding, vomiting, and other associated symptoms. Relevant previous medical history, history of recurrent respiratory infections, immunization status, breastfeeding and dietary history, and other factors potentially affecting nutritional status were documented.

Clinical examination was performed at presentation, with particular attention to the respiratory system. Body temperature, respiratory rate, heart rate, and peripheral oxygen saturation (SpO_2) were recorded. The child was assessed for clinical manifestations of respiratory distress, including tachypnea, chest indrawing, nasal flaring, grunting, cyanosis, wheezing, and abnormal breath sounds. The severity of the acute respiratory tract infection was determined according to the clinical findings, with particular consideration of respiratory distress, hypoxemia, feeding difficulty, and other clinical indicators of severe disease.

Nutritional status was assessed at the time of presentation using standardized anthropometric measurements. Weight and height or length were measured using appropriate equipment and techniques. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared when applicable. The anthropometric measurements were interpreted according to age- and sex-specific WHO growth standards. Nutritional status was categorized according to the relevant anthropometric indices, including normal nutritional status, undernutrition, wasting, stunting, and overweight/obesity where applicable. Mid-upper-arm circumference (MUAC) and assessment for bilateral pitting nutritional oedema were also performed when appropriate for the child's age.

The principal exposure variable was the child's nutritional status, while the principal outcome was the severity of the acute respiratory tract infection. The relationship between nutritional categories and indicators of respiratory severity was subsequently assessed. Clinical indicators including respiratory rate, oxygen saturation, respiratory distress, and other relevant findings were compared between children with different nutritional statuses.

Laboratory and radiological investigations were not performed routinely for research purposes but were requested according to the clinical condition of each child and the treating physician's assessment. When available, relevant laboratory findings and chest radiographic findings were recorded and considered in the clinical assessment of disease severity.

The collected data were checked for completeness, coded, entered into a computerized database, and analyzed using the Statistical Package for the Social Sciences (SPSS). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Chi-square test (χ^2) or Fisher's exact test was used to assess associations between categorical variables, while the independent-samples t-test or Mann–Whitney U test was used to compare continuous variables according to data distribution. For comparisons involving more than two groups, one-way analysis of variance (ANOVA) or the Kruskal–Wallis test was applied as appropriate. Correlation analysis was used, where appropriate, to assess relationships between nutritional indices and continuous indicators of respiratory disease severity. Binary logistic regression analysis was performed to identify independent factors associated with severe acute respiratory tract infection, with results expressed as odds ratios (ORs) and 95% confidence intervals (CIs). A P-value <0.05 was considered statistically significant, and all statistical tests were two-tailed.

3-RESULTS

Table 1 shows the demographic characteristics of the studied children (n=121). The largest proportion of children were aged >3–5 years, comprising 39 (32.2%), followed by those aged >1–2 years, 35 (28.9%), and >2–3 years, 29 (24.0%), while children aged 6–12 months represented 18 (14.9%). The mean age was 2.7 ± 1.4 years, with an age range of 0.5–5 years. Males predominated slightly, accounting for 67 (55.4%) compared with 54 (44.6%) females. Most children were from urban areas, 76 (62.8%), whereas 45 (37.2%) were from rural areas.

Table 1: Demographic characteristics of the studied children (n=121).

Characteristic	Number	Percent
6–12 months	18	14.9
>1–2 years	35	28.9
>2–3 years	29	24.0
>3–5 years	39	32.2
Male	67	55.4
Female	54	44.6
Urban	76	62.8
Rural	45	37.2
Mean age ± SD	2.7 ± 1.4 years	
Age range	0.5–5 years	

Table 2 demonstrates the clinical characteristics of acute respiratory tract infections among the studied children. Cough was the most frequent presenting symptom, occurring in 115 (95.0%) children, followed by fever in 102 (84.3%). Difficulty in breathing was reported in 61 (50.4%), while wheezing was present in 38 (31.4%) and poor feeding in 42 (34.7%). On clinical examination, tachypnea was observed in 58 (47.9%), crepitations in 46 (38.0%), wheezing in 37 (30.6%), and chest indrawing in 34 (28.1%). Regarding oxygen saturation, 18 (14.9%) children had SpO_2 <92%, while 27 (22.3%) had SpO_2 of 92–94% and 76 (62.8%) had SpO_2 ≥95%.

Table 2: Clinical characteristics of acute respiratory tract infections (n=121).

Variable	Number	Percent
Fever	102	84.3
Cough	115	95.0
Difficulty in breathing	61	50.4
Wheezing	38	31.4
Poor feeding	42	34.7
Vomiting	24	19.8
Tachypnea	58	47.9
Chest indrawing	34	28.1
Crepitations	46	38.0
SpO_2 <92%	18	14.9
SpO_2 92–94%	27	22.3
SpO_2 ≥95%	76	62.8

Table 3 shows the nutritional status of the studied children. More than half of the children, 62 (51.2%), had normal nutritional status. However, nutritional abnormalities were relatively common, including underweight in 23 (19.0%), wasting in 21 (17.4%), and stunting in 29 (24.0%). Overweight or obesity was identified in 15 (12.4%) children, while bilateral pitting nutritional oedema was observed in 2 (1.7%). The mean BMI-for-age Z-score was −0.42 ± 1.72.

Table 3: Nutritional status of the studied children (n=121).

Nutritional category	Number	Precent
Normal nutritional status	62	51.2
Underweight	23	19.0
Wasting	21	17.4
Stunting	29	24.0
Overweight/obesity	15	12.4
Bilateral pitting oedema	2	1.7
Mean BMI-for-age Z-score ± SD	-0.42 ± 1.72	

Table 4 demonstrates the severity of acute respiratory tract infections among the studied children. More than two-fifths of the children, 53 (43.8%), had mild infection, while 45 (37.2%) had moderate infection and 23 (19.0%) had severe infection. Thus, approximately one-fifth of the study population presented with severe acute respiratory tract infection.

Table 4: Severity of acute respiratory tract infection (n=121).

Severity	Number	Percent
Mild	53	43.8
Moderate	45	37.2
Severe	23	19.0
Total	121	100.0

Table 5 shows the distribution of nutritional status according to the severity of acute respiratory tract infection. Children with normal nutritional status were predominantly classified as having mild disease, with 36 (58.1%) having mild infection, compared with only 4 (6.5%) having severe infection. In contrast, severe infection represented a considerably larger proportion among children with underweight, wasting, and stunting. Among children with wasting, 7 (33.3%) had severe infection, compared with 5 (23.8%) with mild infection. Similarly, 8 (27.6%) of children with stunting had severe infection.

Table 5: Nutritional status according to infection severity.

Nutritional status	Mild n (%)	Moderate n (%)	Severe n (%)	P-value
Normal	36 (58.1)	22 (35.5)	4 (6.5)	**<0.001**
Underweight	7 (30.4)	10 (43.5)	6 (26.1)	
Wasting	5 (23.8)	9 (42.9)	7 (33.3)	
Stunting	9 (31.0)	12 (41.4)	8 (27.6)	
Overweight/obesity	8 (53.3)	4 (26.7)	3 (20.0)	

Table 6 demonstrates the comparison of anthropometric indices according to infection severity. Mean weight-for-age Z-score progressively decreased from −0.10 ± 1.12 among children with mild infection to −0.72 ± 1.29 among those with moderate infection and −1.31 ± 1.38 among those with severe infection, with a highly significant difference (P<0.001). Height-for-age Z-score also decreased with increasing disease severity, from −0.38 ± 1.24 in mild disease to −1.18 ± 1.45 in severe disease (P=0.019). Similarly, weight-for-height Z-score and BMI-for-age Z-score were progressively lower among children with more severe infection (P=0.002 and P=0.031, respectively). Mean MUAC was also significantly lower among children with severe infection, decreasing from 14.7 ± 1.6 cm in mild cases to 13.3 ± 1.8 cm in severe cases (P=0.004).

Table 6: Comparison of anthropometric indices according to infection severity.

Parameter	Mild (n=53)	Moderate (n=45)	Severe (n=23)	P-value
Weight-for-age Z-score	-0.10 ± 1.12	-0.72 ± 1.29	-1.31 ± 1.38	**<0.001**
Height-for-age Z-score	-0.38 ± 1.24	-0.81 ± 1.37	-1.18 ± 1.45	**0.019**
Weight-for-height Z-score	0.02 ± 1.18	-0.51 ± 1.27	-0.96 ± 1.31	**0.002**
BMI-for-age Z-score	-0.18 ± 1.42	-0.62 ± 1.69	-1.05 ± 1.83	**0.031**
MUAC (cm)	14.7 ± 1.6	14.1 ± 1.7	13.3 ± 1.8	**0.004**

Table 7 shows selected clinical indicators according to nutritional status. Undernourished children had a significantly higher mean respiratory rate than children with normal nutritional status (40.6 ± 9.2 versus 35.8 ± 7.1 breaths/min, P=0.003). Conversely, mean oxygen saturation was significantly lower among undernourished children (93.9 ± 3.5% versus 96.0 ± 2.4%, P<0.001). Tachypnea was present in 63.8% of undernourished children compared with 35.5% of those with normal nutritional status (P=0.004), while chest indrawing occurred in 44.7% versus 17.7%, respectively (P=0.003). SpO_2 <92% was also significantly more frequent among undernourished children (27.7% versus 8.1%, P=0.008). Poor feeding was similarly more common among undernourished children (48.9% versus 22.6%, P=0.005).

Table 7: Selected clinical indicators according to nutritional status.

Clinical indicator	Normal (n=62)	Undernourished* (n=47)	P-value
Mean respiratory rate/min	35.8 ± 7.1	40.6 ± 9.2	**0.003**
Mean SpO_2 (%)	96.0 ± 2.4	93.9 ± 3.5	**<0.001**
Tachypnea	22 (35.5%)	30 (63.8%)	**0.004**
Chest indrawing	11 (17.7%)	21 (44.7%)	**0.003**
SpO_2 <92%	5 (8.1%)	13 (27.7%)	**0.008**
Poor feeding	14 (22.6%)	23 (48.9%)	**0.005**

Table 8 demonstrates the association between nutritional status and severe acute respiratory tract infection. Severe infection occurred in 19 (82.6%) of the children classified as undernourished in the severe-infection group, compared with 28 (28.6%) among the non-severe group. Undernutrition was associated with markedly increased odds of severe acute respiratory tract infection, with a crude OR of 11.12 (95% CI: 4.03–30.66, P<0.001). In contrast, normal nutritional status was used as the reference category. Age ≤2 years, male sex, and urban residence were not significantly associated with severe infection.

Table 8: Association between nutritional status and severe acute respiratory tract infection.

Factor	Severe ARTI n (%)	Non-severe ARTI n (%)	Crude OR (95% CI)	P-value
Undernutrition*	19 (82.6)	28 (28.6)	11.12 (4.03–30.66)	**<0.001**
Normal nutritional status	4 (17.4)	58 (59.2)	Reference	
Age ≤2 years	12 (52.2)	41 (41.8)	1.52 (0.63–3.67)	0.35
Male sex	13 (56.5)	54 (55.1)	1.06 (0.45–2.51)	0.89
Urban residence	14 (60.9)	62 (63.3)	0.90 (0.37–2.19)	0.81

Table 9 shows the results of multivariable logistic regression analysis for factors associated with severe acute respiratory tract infection. After adjustment for the other variables included in the model, undernutrition remained strongly associated with severe respiratory infection, with an adjusted OR of 7.84 (95% CI: 2.67–23.04, P<0.001). Wasting was independently associated with severe infection (adjusted OR=2.96, 95% CI: 1.08–8.12, P=0.035), as was stunting (adjusted OR=2.41, 95% CI: 1.01–5.77, P=0.048). SpO_2 <92% was strongly associated with severe infection (adjusted OR=5.72, 95% CI: 1.92–17.04, P=0.002), while tachypnea was also independently associated with severity (adjusted OR=2.63, 95% CI: 1.04–6.64, P=0.041). In contrast, age ≤2 years and male sex were not statistically significant predictors.

Table 9: Multivariable logistic regression analysis of factors associated with severe acute respiratory tract infection.

Predictor	Adjusted OR	95% CI	P-value
Undernutrition*	7.84	2.67–23.04	**<0.001**
Wasting	2.96	1.08–8.12	**0.035**
Stunting	2.41	1.01–5.77	**0.048**
SpO_2 <92%	5.72	1.92–17.04	**0.002**
Tachypnea	2.63	1.04–6.64	**0.041**
Age ≤2 years	1.34	0.56–3.23	0.51
Male sex	1.08	0.47–2.49	0.86

Table 10 demonstrates the diagnostic performance of selected nutritional indicators for predicting severe acute respiratory tract infection. Weight-for-height Z-score showed the highest discriminatory ability among the individual nutritional indicators, with an AUC of 0.763, sensitivity of 78.3%, and specificity of 67.3%. Weight-for-age Z-score demonstrated an AUC of 0.748, while MUAC had an AUC of 0.741. BMI-for-age Z-score showed a somewhat lower but still moderate discriminatory ability, with an AUC of 0.721. Importantly, the combination of nutritional indicators produced the highest AUC of 0.801, with sensitivity of 78.3% and specificity of 75.5%. These findings suggest that combined anthropometric assessment provides better discrimination of severe respiratory infection than any single nutritional indicator alone.

Table 10: ROC analysis of nutritional indicators for predicting severe acute respiratory tract infection.

Nutritional indicator	AUC	95% CI	Sensitivity (%)	Specificity (%)
BMI-for-age Z-score	0.721	0.618–0.824	69.6	70.4
Weight-for-age Z-score	0.748	0.652–0.844	73.9	69.4
Weight-for-height Z-score	0.763	0.670–0.856	78.3	67.3
MUAC	0.741	0.640–0.842	73.9	66.3
Combined nutritional indicators	0.801	0.711–0.891	78.3	75.5

4- DISCUSSION

Acute respiratory tract infections remain an important cause of morbidity, hospitalization, and mortality among children, particularly in low- and middle-income countries. Nutritional status is an important determinant of susceptibility to infection and the ability to tolerate and recover from acute illness. The present hospital-based cross-sectional study evaluated the relationship between nutritional status and severity of ARTIs among 121 children attending Al-Khansaa Teaching Hospital in Nineveh Governorate, Iraq. Overall, the findings demonstrated a significant association between nutritional abnormalities, particularly undernutrition, wasting, and stunting, and greater clinical severity.

The mean age of the children was 2.7 ± 1.4 years, with a slight male predominance and approximately two-thirds from urban areas. Cough was the most frequent symptom (95.0%), followed by fever (84.3%), while difficulty breathing, tachypnea, wheezing, chest indrawing, poor feeding, and reduced oxygen saturation were also observed. These findings are consistent with the clinical spectrum of pediatric respiratory infection. Respiratory rate, oxygen saturation, chest indrawing, feeding ability, and other danger signs are important components of assessing disease severity.[1,10]

Nutritional assessment showed that 51.2% of children had normal nutritional status, while stunting, underweight, and wasting were present in 24.0%, 19.0%, and 17.4%, respectively. Overweight or obesity was identified in 12.4%. The coexistence of different forms of nutritional abnormality reflects the double burden of malnutrition increasingly recognized in low- and middle-income countries.[2,11] Standardized indicators such as weight-for-age, height-for-age, weight-for-height, and BMI-for-age are recommended for assessing nutritional status in children.[9]

The principal finding was a significant relationship between nutritional status and ARTI severity (P<0.001). Children with normal nutritional status were predominantly classified as having mild disease, whereas underweight, wasting, and stunting were increasingly represented among children with moderate and severe disease. Severe disease occurred in only 6.5% of children with normal nutritional status, compared with 26.1% of underweight children and 33.3% of wasted children. These findings support the hypothesis that nutritional impairment is associated with a greater clinical burden of acute respiratory infection. The observed association is biologically plausible because malnutrition can impair innate and adaptive immunity, compromise epithelial and mucociliary defenses, and reduce immune-cell function. Deficiencies in energy, protein, and essential micronutrients may consequently increase susceptibility to respiratory infection. Conversely, acute infection may further worsen nutritional status through anorexia, reduced intake, fever, inflammation, vomiting, and increased metabolic requirements. Thus, the relationship between malnutrition and infection is potentially bidirectional.[3,4,8]

Undernutrition showed a particularly strong association with severe ARTI. The crude odds ratio was 11.12 (95% CI: 4.03–30.66; P<0.001), and undernutrition remained independently associated with severe disease after adjustment, with an adjusted odds ratio of 7.84 (95% CI: 2.67–23.04; P<0.001). This finding is consistent with previous evidence showing increased risk of adverse pneumonia outcomes among underweight children, with greater risk associated with increasing severity of undernutrition.[5,6]

Wasting was independently associated with severe ARTI (adjusted OR 2.96, 95% CI: 1.08–8.12; P=0.035). Wasting reflects acute or recent nutritional deficiency and may indicate limited energy and protein reserves during respiratory illness. WHO guidance emphasizes assessment of children with acute malnutrition for medical complications, including respiratory infection, fast breathing, chest indrawing, and low oxygen saturation.[7]

Stunting was also associated with increasing disease severity. The mean height-for-age Z-score progressively decreased from mild to severe disease, and stunting remained independently associated with severe ARTI (adjusted OR 2.41, 95% CI: 1.01–5.77; P=0.048). As a marker of chronic nutritional deprivation, stunting may reflect prolonged inadequate intake, recurrent infection, and adverse environmental conditions, all of which may affect immune competence and vulnerability to infection.[3,4,11]

The progressive reduction in weight-for-age, height-for-age, weight-for-height, and BMI-for-age Z-scores with increasing disease severity provides additional support for the nutritional–severity relationship. These findings indicate that the association was not restricted to a single nutritional classification but was also evident across continuous anthropometric measures. Such assessment is consistent with WHO child growth standards and nutritional assessment recommendations.[7,9]

Undernourished children also demonstrated more pronounced respiratory compromise. They had higher respiratory rates and lower oxygen saturation, while tachypnea, chest indrawing, oxygen saturation below 92%, and poor feeding were significantly more frequent. These findings are clinically important because hypoxemia and increased work of breathing are recognized indicators of severe respiratory illness.[10] The greater frequency of poor feeding may reflect both the effect of respiratory distress on oral intake and the consequences of pre-existing nutritional vulnerability.[3,4]

Age, sex, and residence were not significantly associated with severe ARTI in the present analysis. Although children aged ≤2 years showed a slightly higher crude odds of severe disease, the association was not statistically significant. These findings suggest that, within this hospital-based sample, nutritional status may have been more strongly related to severity than the demographic variables examined. However, the relatively small sample size may have limited detection of smaller effects.

The ROC analysis showed moderate discriminatory performance for individual nutritional indicators. Weight-for-height Z-score had an AUC of 0.763, followed by weight-for-age Z-score (0.748), MUAC (0.741), and BMI-for-age Z-score (0.721). Combining nutritional indicators increased the AUC to 0.801. These findings suggest that nutritional assessment may contribute to clinical risk stratification, although anthropometric measures should complement rather than replace established clinical assessment of respiratory severity.

The presence of overweight or obesity in 12.4% of children also highlights the changing nutritional profile of pediatric populations. The coexistence of undernutrition and excess weight reflects the double burden of malnutrition.[2,11] However, the present sample was not sufficiently large to determine whether overweight or obesity independently influenced ARTI severity. The findings have important clinical implications. Nutritional assessment should be incorporated into the evaluation of children presenting with acute respiratory infection, including appropriate anthropometric measurements and assessment for nutritional oedema.[7,9] At the same time, respiratory assessment should include respiratory rate, oxygen saturation, work of breathing, chest indrawing, feeding ability, and other danger signs.[1,10] Early identification of nutritional vulnerability may help clinicians recognize children who require closer monitoring and comprehensive supportive care.

Several limitations should be considered. The cross-sectional design prevents firm conclusions regarding temporality or causality. The single-hospital setting may limit generalizability, and the modest sample size may have reduced statistical power for less frequent nutritional conditions. Acute illness may also influence feeding, hydration, and anthropometric measurements. Residual confounding from socioeconomic, dietary, environmental, and infectious factors cannot be excluded.

5- CONCLUSION AND RECOMMENDATION

The present study concluded that nutritional status was significantly associated with the severity of acute respiratory tract infections among children. Undernourished children showed more severe respiratory manifestations, including higher respiratory rate, lower oxygen saturation, tachypnea, chest indrawing, and poor feeding, and undernutrition remained an independent predictor of severe ARTI, while wasting and stunting were also independently associated with severe disease. Therefore, nutritional assessment should be incorporated into the routine evaluation of children presenting with acute respiratory tract infections, with particular attention to children with undernutrition, wasting, or stunting. Respiratory assessment, including respiratory rate, oxygen saturation, chest indrawing, and feeding ability, should be performed routinely to facilitate early recognition of severe disease. Appropriate nutritional support should be integrated with the management of respiratory infections, and parents and caregivers should receive education regarding adequate nutrition, appropriate feeding practices, immunization, recognition of respiratory danger signs, and timely healthcare seeking. Further multicenter studies with larger sample sizes and prospective or longitudinal designs are recommended to clarify the temporal and causal relationship between nutritional status and ARTI severity and to evaluate whether nutritional interventions can improve clinical outcomes.

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