ORIGINAL ARTICLE

Severe Acute Malnutrition in Children with Recurrent Pneumonia

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ABSTRACT

OBJECTIVE: To determine the frequency of severe acute malnutrition (SAM) in children with recurrent pneumonia aged 1-5 years.

METHODOLOGY: This cross-sectional study was conducted at the Department of Pediatrics, Abbasi Shaheed Hospital, Karachi, Pakistan, from September 2025 to March 2026. A total of 296 children aged 1-5 years and diagnosed with recurrent pneumonia were enrolled following non-probability consecutive sampling. We analyzed data in IBM SPSS Statistics version 26.0. We used multivariate binary logistic regression of identify predictors of SAM in recurrent pneumonia, with $p<0.05$ considered significant.

RESULTS: In a total of 296 children, the median age was 2.8 (1.9–4.1) years, while 172 (58.1%) were boys. We identified SAM in 62 (20.9%) children. In multivariate binary logistic regression, low birth weight remained associated with severe acute malnutrition (SAM), with affected children having nearly threefold higher odds of SAM ($p=0.002$). Delayed complementary feeding was associated with 2-fold higher odds of SAM. Children with diarrhea had significantly higher odds of SAM than those without diarrhea ($p=0.025$). Low family income remained an independent predictor with approximately twofold higher odds of SAM ($p=0.033$). Maternal illiteracy was associated with increased odds of SAM ($p=0.047$).

CONCLUSION: SAM is frequent among children with recurrent pneumonia and is linked with low birth weight, delayed complementary feeding, diarrhea, low family income, and maternal illiteracy.

KEYWORDS: Child, cough, fever, malnutrition, pneumonia.

INTRODUCTION

Severe acute malnutrition (SAM) is a major public health concern, particularly in developing countries like Pakistan, where it significantly contributes to pediatric morbidity and mortality[1]. Inadequate dietary intake, infections, and poor access to healthcare are some of the major factors behind SAM[2]. In 2022, it was estimated that around 22% of children below 5 years are stunted and 7% wasted, while more than 90% of these children reside in Asia and Africa[3]. Local data revealed that approximately 40% of children below 5 years are affected by stunting, and 17.7% are wasted[4].

SAM is often associated with multiple health complications, including delayed recovery from infections, stunted growth, and increased mortality[5]. Pneumonia remains one of the top causes of death in children under the age of five. Annually, an estimated 138 million new episodes of pneumonia occur, and 52% of these occur in 5 countries, including Pakistan[6]. Malnutrition weakens the immune system, making children more susceptible to infections like pneumonia[7]. In areas with high rates of malnutrition, recurrent pneumonia becomes a significant concern that worsens health outcomes. Children suffering from SAM are more likely to develop pneumonia, and in turn, pneumonia can exacerbate the condition of a malnourished child, creating a vicious cycle of illness.

The novelty of this study lies in the local context of Pakistan, where malnutrition rates are high, and pneumonia continues to be a leading cause of pediatric morbidity and mortality. Unfortunately, there is scarcity of local data on the burden of SAM in recurrent pneumonia are scarce, as this has not been comprehensively studied in the region. Therefore, this research aimed of determine the frequency of SAM in recurrent pneumonia among children aged 1-5 years at a tertiary care hospital in Karachi, Pakistan. Addressing the gap in understanding the coexistence of SAM and recurrent pneumonia in Pakistani children would not only furnish local data but also provide valuable insights.

METHODOLOGY

This cross-sectional study was conducted at the Department of Pediatrics, Abbasi Shaheed Hospital, Karachi, Pakistan, from September 2025 to March 2026. The study began after approval from the institutional ethics committee (IRB/KMDC/KMU/130/2025, dated 27-08-2025). We calculated a sample size of 296 using the online OpenEpi sample size calculator, assuming an expected proportion of SAM in children with recurrent pneumonia of 14.4%,8 with a 95% confidence level and a 4% margin of error. We used a non-probability, consecutive sampling technique. We obtained written informed consent from the parents/guardians of all participants after briefing them on the study's objective and safety. The inclusion criteria were children of any gender aged 1-5 years diagnosed with recurrent pneumonia. The exclusion criteria were children with congenital or chronic conditions unrelated to malnutrition or pneumonia, such as cystic fibrosis or congenital heart disease (as per medical history). We also excluded children with acute illnesses other than pneumonia, such as sepsis or urinary tract infections (as per clinical examination and relevant laboratory investigations), or with a history of asthma or bronchopulmonary dysplasia. Pneumonia was clinically diagnosed by a healthcare provider based on symptoms (cough, fever, difficulty breathing) and confirmed with radiological findings (e.g., consolidation, pleural effusion, lung abscesses) on a chest X-ray, further classified as i) bacterial pneumonia: fever >38.5°C, cough, respiratory distress with a respiratory rate ≥40 breaths/minute, chest radiograph showing lobar consolidation or pleural effusion, and leukocytosis with WBC >15,000/mm³ and neutrophils >70%; ii) viral pneumonia: gradual onset with cough, wheeze, rhinorrhea, fever <38.5 °C, chest X-ray showing bilateral interstitial infiltrates without lobar consolidation, and lymphocytosis (>40%, WBC <10,000/mm³); iii) mixed pneumonia: combination of bacterial (fever, consolidation) and viral (wheeze, interstitial infiltrates) features; chest X-ray showing both lobar consolidation and interstitial changes; WBC 10,000–20,000/mm³ with mixed pattern; iv) aspiration pneumonia: pneumonia following choking, vomiting, or swallowing difficulty; chest X-ray showing patchy infiltrates in dependent lung zones (commonly right middle/lower lobe); neutrophilic leukocytosis (>12,000/mm³); v) unspecified pneumonia: clinical pneumonia with cough or difficulty breathing and a respiratory rate ≥40 breaths/minute, with chest radiographic infiltrates that could not be classified as bacterial, viral, mixed, or aspiration pneumonia. A consultant radiologist and a pediatrician independently reviewed chest radiographs using predefined radiological criteria. We resolved any disagreement in interpretation by consensus after joint review of the radiograph. We defined recurrent pneumonia as two or more separate episodes of pneumonia within the preceding 12 months, with clinical recovery and documented radiographic clearing between episodes. We verified previous episodes from available hospital records and prior chest radiographs. When previous radiographs were unavailable, we reviewed documented physician diagnoses and treatment records or prescriptions, supplemented by caregiver history.

Demographic and clinical information of the eligible children enrolled from the Emergency Department, Outpatient Department, and Inpatient Department of Pediatrics, which included age, gender, weight, height, weight-to-height Z-score, mid-upper arm circumference (MUAC), diarrhea, and vaccination status, was noted. Trained study assessors obtained anthropometric measurements using standardized procedures. We measured weight using a calibrated digital pediatric weighing scale, length or height using an infantometer or stadiometer by age, and MUAC using a non-stretchable MUAC tape. We measured MUAC on the left arm at the midpoint between the acromion and olecranon using a non-stretchable measuring tape, with the arm relaxed and the tape applied snugly without compressing the skin. We recorded the measurement to the nearest 0.1 cm. Equipment was checked and calibrated regularly. We took each measurement twice and recorded the average.

We obtained a third measurement when the first two readings showed a substantial discrepancy. We assessed immunization status based on the child's history of receiving age-appropriate vaccination. We documented nutritional history, including feeding history, complementary feeding practices, and details on prematurity at birth and low birth weight. We defined complementary feeding as the introduction of solid, semi-solid, or soft foods in addition to breast milk or formula. We classified introduction at 6 completed months as timely, before 6 months as early, and after 6 months as delayed. We defined prematurity at birth as birth before 37 weeks of gestation. We defined low birth weight as a birth weight <2500 grams. We recorded parental education level, monthly family income, type of residence, and number of family members. We performed laboratory investigations, including hemoglobin levels (g/dL), white blood cell count (103/mm^3), and platelet count (103/mm^3), along with a chest X-ray. SAM was assessed following the criteria of a weight-for-height Z-score of less than -3 standard deviations (SD) below the median of the WHO reference population, an MUAC < 11.5 cm, or the presence of edema. We designed a detailed, structured data collection proforma to capture all necessary information.

We entered and analyzed data using IBM SPSS Statistics, version 26.0. We represented categorical variables using frequencies and percentages. We expressed continuous variables as means with SD or medians and interquartile ranges (IQR), depending on the Shapiro-Wilk test. We stratified data by effect modifiers such as gender, age, family income status, number of family members, residence, parental education, immunization status, types of pneumonia, feeding history, complementary feeding, prematurity at birth, low birth weight, hemoglobin, WBC, and platelet count. We used a post-stratification chi-square test or Fisher's exact test for categorical data, and an independent-samples t-test or Mann-Whitney U test for numeric data, to assess their association with the frequency of SAM. After univariate analysis, we entered variables with $p < 0.10$ into a multivariable logistic regression model. We did not include anthropometric parameters because they are components of the SAM diagnostic criteria. We excluded prematurity from the final model because of collinearity with low birth weight. We considered $p < 0.05$ significant.

RESULTS

During the study period, we screened 352 children aged 1 to 5 years presenting with suspected or documented recurrent pneumonia for eligibility. Of these, 56 children were excluded. The reasons for exclusion were not fulfilling the operational definition of recurrent pneumonia in 18 children, congenital or chronic disorders such as congenital heart disease or cystic fibrosis in 12 children, acute illness other than pneumonia in 9 children, history of asthma or bronchopulmonary dysplasia in 8 children, refusal of parental consent in 6 children, and incomplete anthropometric or radiological data in 3 children. Of the 296 enrolled children, all were included in the final analysis.

In a total of 296 children, the median age was 2.8 (1.9–4.1) years, while 172 (58.1%) were boys and 124 (41.9%) were girls. The median weight and height were 11.2 (9.3–13.8) kg and 87.0 (79.0–96.0) cm, respectively. The median weight-for-height Z-score was -1.8 (-2.7 to -0.9), and the median MUAC was 13.1 (11.9–14.4) cm. Diarrhea was documented in 79 (26.7%) children. Regarding nutritional and birth history, exclusive breastfeeding was reported in 118 (39.9%) children, mixed feeding in 103 (34.8%), and formula feeding in 75 (25.3%). Complementary feeding was timely in 181 (61.1%) children and delayed in 115 (38.9%). Prematurity at birth was documented in 68 (23.0%) children, while low birth weight was reported in 74 (25.0%). The median family size was 7.0 (5.0–9.0) members.

SAM was diagnosed in 62 (20.9%) children. SAM was significantly more common among children with diarrhea($p<0.001$), incomplete vaccination status ($p=0.031$), a history of mixed feeding or formula feeding ($p=0.043$), and delayed complementary feeding ($p=0.002$). SAM was also significantly more frequent among children with prematurity ($p=0.004$), low birth weight ($p<0.001$), low family income ($p=0.001$), rural residence ($p=0.008$), maternal illiteracy ($p=0.002$), and family members >6 ($p=0.005$). **Table I** presents baseline sociodemographic, nutritional, and clinical characteristics.

Table I: Characteristics of children with recurrent pneumonia according to severe acute malnutrition status (n=296)

Variables		SAM (n=62)	No SAM (n=234)	OR (95% CI)	P value
Age, years		2.3 (1.5–3.7)	2.9 (2.0–4.3)	—	0.028
Male gender		39 (62.9%)	133 (56.8%)	1.3 (0.7–2.3)	0.393
Weight, kg		8.9 (7.8–10.5)	11.9 (10.1–14.3)	—	<0.001
Height, cm		81.0 (75.0–89.0)	89.0 (81.0–97.0)	—	<0.001
Weight-for-height Z-score		-3.4 (-4.0 to -3.1)	-1.3 (-2.0 to -0.5)	—	<0.001
Middle upper arm circumference, cm		11.0 (10.3–11.4)	13.8 (12.8–14.7)	—	<0.001
Diarrhea		27 (43.5%)	52 (22.2%)	2.7 (1.5–4.9)	0.001
Vaccination status	Fully vaccinated	32 (51.6%)	156 (66.7%)	-	0.031
	Partially/not vaccinated	30 (48.4%)	78 (33.3%)	1.9 (1.1–3.4)	
History of feeding practices	Exclusive breastfeeding	18 (29.0%)	100 (42.7%)	-	0.043
	Mixed feeding	21 (33.9%)	82 (35.0%)	1.4 (0.7–2.9)	
	Formula feeding	23 (37.1%)	52 (22.2%)	2.5 (1.2–5.1)	
Complimentary feeding	Timely complementary feeding	27 (43.5%)	154 (65.8%)	-	0.002
	Delayed complementary feeding	35 (56.5%)	80 (34.2%)	2.5 (1.4–4.5)	
Prematurity		23 (37.1%)	45 (19.2%)	2.5 (1.3–4.6)	0.004
Low birth weight		28 (45.2%)	46 (19.7%)	3.4 (1.8–6.2)	<0.001
Low family income		38 (61.3%)	86 (36.8%)	2.7 (1.5–4.9)	0.001
Rural residence		29 (46.8%)	67 (28.6%)	2.2 (1.2–3.9)	0.008
Maternal illiteracy		35 (56.5%)	79 (33.8%)	2.5 (1.4–4.6)	0.002
Family members >6		40 (64.5%)	102 (43.6%)	2.4 (1.3–4.3)	0.005

Chest radiography revealed lobar consolidation in 129 (43.6%) children, interstitial infiltrates in 88 (29.7%), pleural effusion in 31 (10.5%), patchy infiltrates in dependent lung segments in 22 (7.4%), and mixed radiological findings in 26 (8.8%). Classification of pneumonia demonstrated bacterial pneumonia in 126 (42.6%) children, viral pneumonia in 79 (26.7%), mixed pneumonia in 38 (12.8%), aspiration pneumonia in 21 (7.1%), and unspecified pneumonia in 32 (10.8%). Analysis by pneumonia type showed significant variation in SAM frequency ($p<0.001$). SAM was identified in 34 (27.0%) children with bacterial pneumonia, 11 (13.9%) with viral pneumonia, 10 (26.3%) with mixed pneumonia, 5 (23.8%) with aspiration pneumonia, and 2 (6.3%) with unspecified pneumonia. Compared with viral pneumonia, bacterial pneumonia had significantly higher odds of SAM (OR 2.3, 95% CI 1.1–4.7, $p<0.001$). Children with SAM had significantly lower median haemoglobin levels ($p<0.001$) and higher median white blood cell counts ($p=0.008$); details are given in **Table II**.

Table II: Laboratory parameters according to severe acute malnutrition status

Variable	SAM (n=62)	No SAM (n=234)	P value
Hemoglobin, g/dL	9.4 (8.8–10.2)	10.7 (9.8–11.8)	<0.001
White blood cell, $\times 10^3/mm^3$	15.8 (12.9–18.9)	13.3 (10.4–16.7)	0.008
Platelets, $\times 10^3/mm^3$	318.0 (236.0–399.0)	324.0 (251.0–407.0)	0.611

In multivariate binary logistic regression (**Table III**), low birth weight remained associated with SAM, with affected children having nearly threefold higher odds of SAM ($p=0.002$). Delayed complementary feeding was significantly associated with SAM ($p=0.012$). Children with diarrhoea had significantly higher odds of SAM than those without diarrhoea ($p=0.025$). Low family income remained an independent predictor with approximately twofold higher odds of SAM ($p=0.033$). Maternal illiteracy was associated with increased odds of SAM ($p=0.047$).

Table III: Multivariable logistic regression analysis for predictors of severe acute malnutrition

Variable	Adjusted OR	95% CI	P-value
Low birth weight	2.9	1.5–5.7	0.002
Delayed complementary feeding	2.2	1.2–4.3	0.012
Diarrhea	2.1	1.1–4.1	0.025
Low family income	2.0	1.1–3.9	0.033
Maternal illiteracy	1.9	1.0–3.8	0.047
Bacterial pneumonia	1.9	0.9–3.9	0.091

DISCUSSION

The present study found SAM in 20.9% of children aged 1-5 years with recurrent pneumonia. Low birth weight, delayed complementary feeding, diarrhea, low family income, and maternal illiteracy remained independent predictors of SAM after adjustment. Bacterial pneumonia showed higher odds of SAM but was not statistically significant in the final model. The frequency of SAM was relatively higher than the acute malnutrition burden reported by Özçelik et al., in children with recurrent pneumonia where acute malnutrition was documented in 14.4% of cases[8].

Earlier studies have described the relationship between recurrent respiratory illness and nutritional compromise, although local data focused specifically on SAM in recurrent pneumonia remain limited. Srivastava et al.[9] found persistent pneumonia in 6.8% of under-five children with severe pneumonia and concluded that malnutrition was a major determinant of persistence. This study extends this evidence by focusing on recurrent pneumonia and quantifying SAM using anthropometric criteria. This adds local value because recurrent pneumonia in malnourished children may reflect a cycle in which poor nutrition increases infection susceptibility, and repeated infections further impair appetite, absorption, and growth[10].

Low birth weight was the strongest independent predictor of SAM. These findings are consistent with the South Asian comparative analysis by Chowdhury et al. [11], which reported severe undernutrition in 19.8% of Pakistani under-five children and identified low birth weight as a key determinant in Pakistan, with a strong association after multilevel adjustment. Low birth weight can place children on a weaker growth trajectory from birth, and recurrent infections may then magnify the nutritional deficit. This supports linking antenatal nutrition, birth weight surveillance, and postnatal growth monitoring[12].

Delayed complementary feeding was associated with SAM, and these observations are consistent with evidence from Karachi by Mehmood et al. [13], where complementary feeding was initiated in about 60% of children, and 35.3% were underweight. The present study moves this finding into a clinically vulnerable group by showing that delayed complementary feeding remains associated with SAM even among children already presenting with recurrent pneumonia. Children presenting with repeated pneumonia could be screened not only for anthropometric deficits but also for timing and adequacy of complementary feeding.

Diarrhea was an important predictor of SAM in this study. These observations are aligned with the established interaction between enteric infections and acute malnutrition. Chisti et al.[14], studying SAM children with radiological pneumonia in Bangladesh, found that dehydration was independently linked with both treatment failure and death in the affected children. In the present study, diarrhea likely contributed to nutritional deterioration through reduced intake, malabsorption, and recurrent catabolic stress. From a clinical perspective, nutritional rehabilitation for children with recurrent pneumonia may include active assessment and management of diarrheal illness.

Low family income and maternal illiteracy remained associated with SAM, and these findings are consistent with Chowdhury et al.[11], who found that severe undernutrition in Pakistan was higher among children of families from poor socioeconomic and educational backgrounds. Maternal education influences feeding practices, hygiene, immunization completion, early healthcare-seeking, and recognition of danger signs. Low family income limits food quality, dietary diversity, transport to healthcare facilities, and continuity of treatment[15,16]. Facility-based care may be linked with nutrition counselling, caregiver education, immunization review, and social support pathways[17,18]. The pneumonia subtype analysis provides an important clinical layer in this study. WHO states that pneumonia can be caused by viruses, bacteria, or fungi, with Streptococcus pneumoniae as the most common bacterial cause and respiratory syncytial virus as the most common viral cause in children[19]. The present study supports careful assessment, early antibiotic decision-making where indicated, and close monitoring of malnourished children with recurrent bacterial radiological patterns.

The laboratory findings further support the clinical burden in children with SAM. These patterns may reflect coexistence of anemia, inflammation, and infection burden. Ahmed et al.[20] reported poor recovery outcomes in treated children with SAM, emphasizing the difficulty of achieving satisfactory nutritional recovery in local Pakistani settings. The present study adds that children with recurrent pneumonia and SAM may present with hematological derangements that require attention during clinical management.

This study has limitations. The cross-sectional design limits causal interpretation, and future prospective cohort studies could follow children after pneumonia episodes to determine whether nutritional deficits precede recurrence or worsen after repeated infections. The single-centre design may limit the generalizability of these findings to other community settings and hospitals.

CONCLUSION

SAM is frequent among children with recurrent pneumonia and is linked with low birth weight, delayed complementary feeding, diarrhea, low family income, and maternal illiteracy. These findings support integrated care in which recurrent pneumonia is used as a clinical entry point for nutritional screening, caregiver counselling, and early referral for nutritional rehabilitation.

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AUTHOR CONTRIBUTION

Hasnain MW**:** Data collection, drafting, responsible for data, approved for publication.
Ibrahim Shakoor**:** Conception and design, critical revisions, approved for publication.
Yaseen A**:** Literature review, drafting, critical revisions, responsible for data, approved for publication.
Raheem M**:** Literature review, drafting, critical revisions, proofreading, approved for publication.
Abbas S**:** Data collection, data analysis, data Interpretation, proofreading, critical revision, approved for publication.
Raza SA**:** Data collection, data synthesis, proofreading, approved for publication.

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