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THE FREQUENCY OF PULMONARY TUBERCULOSIS AMONGST SEVERELY ACUTE MALNOURISHED CHILDREN

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Abstract

OBJECTIVE: *To determine the frequency of pulmonary tuberculosis in children aged 2–59 months diagnosed with severe acute malnutrition.*

METHODOLOGY: *This descriptive cross-sectional research was carried out at the Nutrition Stabilization Centre, Ghulam Muhammad Mahar Medical College, Sukkur, between September 2024 and March 2025. A total of 162 male and female children aged 2–59 months, fulfilling WHO standards for severe acute malnutrition (weight-for-height <–3 SD, MUAC <11.5 cm, or bilateral oedema), were selected through consecutive non-probability sampling and evaluated for pulmonary tuberculosis. Data were processed in SPSS version 26 using descriptive measures and Chi-square analysis, considering $p < 0.05$ as statistically significant.*

RESULTS: *Among 162 severely malnourished children (mean age 17.44 ± 11.96 months; 46.9% males and 53.1% females), pulmonary tuberculosis was confirmed in 63 (38.8%) cases. No statistically significant associations were observed between tuberculosis positivity and demographic or clinical characteristics, including age, gender, nutritional status, or clinical indicators ($p > 0.05$).*

CONCLUSION: *This study identified pulmonary tuberculosis in about one-third of children with severe acute malnutrition, emphasizing the considerable overlap between these two conditions. No statistically significant association was observed between tuberculosis positivity and demographic or clinical characteristics, showing that symptoms alone cannot reliably guide diagnosis. Integrating molecular diagnostics such as the GeneXpert assay into nutrition rehabilitation services is essential to enable timely detection and improve treatment outcomes among malnourished children in high-burden regions.*

INTRODUCTION

Tuberculosis (TB) and malnutrition remain leading causes of illness and death among children in low- and middle-income countries. Extensive evidence demonstrates that malnourished children are more vulnerable to infections, including TB, than their well-nourished counterparts. In 2015, nearly one million children developed TB and approximately 170,000 died, while globally about 50 million children were affected by severe wasting—predominantly in Sub-Saharan Africa and Asia—with nearly one million deaths per year [1]. The World Health Organization (WHO) recognizes malnutrition as a critical risk factor

not only for acquiring TB, but also for more severe disease, disability, relapse, and poor treatment outcomes [2]. In high TB-burden settings, Undernutrition is believed to be responsible for substantially to childhood TB progression and mortality [3]. The immunological basis lies in the impairment of cell-mediated immunity by malnutrition: reductions in T-cell proliferation, cytokine secretion, macrophage activation, and delayed-type hypersensitivity responses compromise the ability to contain Mycobacterium tuberculosis [4]. Children suffering from both severe acute malnutrition (SAM) and TB bear a disproportionately high risk: mortality is reported to be up to 40% higher compared to malnourished children without TB [5]. In a study from Pakistan of 222 hospitalized children, 82 (36.9 %) were diagnosed with TB; among these, 58 (70.7 %) were severely poor nutrition. Only 2.4 % were breastfed, and 63.4 % had delayed complementary feeding, both significantly associated with TB occurrence ($p < 0.05$). Though family type, illiteracy, poverty, and immunization status showed trends toward association, these did not reach statistical significance in that sample [6]. Additional studies in Pakistan have documented that paediatric TB cases often present with undernutrition: in one prospective study in Sindh and other regions, a large percentage of children diagnosed with TB were underweight or wasted, reflecting the close interrelationship between nutritional status and TB risk [7].

Beyond Pakistan, multiple regional studies reinforce this link. Indian investigators have found prevalence of pulmonary TB among children with SAM in the range of 5–8 % when active screening is applied, often in association with poverty, delayed feeding practices, and poor immunization coverage [8]. In Ethiopia, retrospective cohort studies report TB incidence densities children below five years with SAM of about 4 per 100 person-months, and cumulative incidence around 7 % over follow-up periods; key predictors included a history of TB contact, pneumonia at baseline, absence of zinc supplementation, and poor appetite [9,10]. A hospital-based study from Bangladesh observed that children with SAM and pneumonia had higher post-discharge mortality and delayed nutritional recovery when concomitant TB was present [11]. A systematic review on child TB and malnutrition noted that undernutrition increases the risk of disease progression, relapse, and mortality, and that TB can in turn worsen nutritional status, creating a vicious cycle [12]. In Zambian settings, children hospitalized with SAM were found to have high TB caseloads, and TB diagnosis was associated with increased in-hospital mortality [13]. Finally, meta-analyses and epidemiologic reviews emphasize that in many TB-endemic settings, undernutrition is among the top modifiable risk factors for TB incidence and poorer outcomes, especially among children in resource-constrained contexts [14].

Despite strong global and regional evidence, there remains a paucity of localized data—especially in urban settings like Sukkur, Sindh—on the burden of lung TB among children with SAM. The proposed study aims to fill this gap by determining the frequency of pulmonary TB among severely acutely malnourished children admitted to tertiary care in Sukkur and exploring associated socio-demographic and feeding-related risk factors. The findings may guide policy for integrated TB-nutrition screening and management strategies in high-burden, low-resource paediatric populations.

METHODOLOGY

This descriptive cross-sectional research was conducted at the Nutrition Stabilization Centre (NSC) of Ghulam Muhammad Mahar Medical College, Sukkur, between September 2024 and March 2025. The NSC serves as a tertiary-level unit that provides nutritional rehabilitation and medical management to children with malnutrition referred from both urban and rural areas of Sindh Province. Prior to the commencement of data collection, ethical approval was obtained from the Institutional Ethical Review Committee. Written informed consent was obtained from the parents or legal guardians of all participants after explaining the objectives, procedures, and potential benefits and risks of the study. Participation was voluntary, and confidentiality of all collected information was maintained throughout.

A total of 162 male and female children aged 2–59 months were enrolled using a non-probability consecutive sampling technique. Eligible participants met the World Health Organization (WHO, 2013) criteria for Severe Acute Malnutrition (SAM), which

included a weight-for-height or length below –3 standard deviations (SD) of the WHO growth reference, a mid–upper arm circumference (MUAC) less than 11.5 cm, or the presence of bilateral pitting nutritional oedema verified by applying gentle pressure to the dorsum of both feet for about ten seconds. Children with pre-existing chronic conditions such as congenital heart disease, chronic kidney disease, or immunodeficiency disorders, and those who were discharged or expired before completion of tuberculosis (TB) evaluation, were excluded from the study.

Pulmonary tuberculosis was identified based on clinical presentation, including a cough lasting more than two weeks, fever, weight loss, and night sweats, supported by chest radiographic findings suggestive of TB, such as hilar lymphadenopathy or pulmonary infiltrates. Microbiological confirmation was obtained through the GeneXpert MTB/RIF assay wherever possible. The Pakistan Paediatric Association (PPA) scoring system was additionally used to support clinical diagnosis, with higher scores indicating greater probability of TB infection.

Data were gathered using a pretested structured questionnaire administered by trained healthcare personnel. The questionnaire recorded demographic details, clinical and anthropometric measurements, immunization status, feeding practices, and information related to tuberculosis. All anthropometric and diagnostic assessments were performed following standard WHO protocols to ensure accuracy and minimize observer bias.

Data were entered and analysed using IBM SPSS Statistics version 26. Continuous variables were expressed as means with standard deviations, while categorical variables were summarized as frequencies and percentages. Associations between study variables and tuberculosis status were evaluated using the Chi-square test, and a p-value below 0.05 was considered statistically significant.

RESULTS

A total of 162 participants were included in the study. The mean age of the participants was 17.44 ± 11.96 months (95% CI: 15.58–19.29), with an average weight of 4.90 ± 1.52 kg (95% CI: 4.66–5.14) and mean height of 64.56 ± 8.56 cm (95% CI: 63.23–65.89). The mean mid-upper arm circumference was 9.54 ± 4.39 cm (95% CI: 8.86–10.22), and the mean SD score was -3.89 ± 0.37 (95% CI: -3.95– -3.83). The mean respiratory rate was 34.13 ± 7.58 breaths per minute (95% CI: 32.95–35.31), while the mean Pakistan Paediatric Association score was 5.57 ± 1.82 (95% CI: 5.29–5.86). Of the total participants, 76 (46.9%) were male and 86 (53.1%) were female. Bilateral pitting oedema was observed in 21 (13.0%) participants, whereas 142 (87.0%) had no oedema. Regarding cough duration, 53 (32.7%) had a cough for less than two weeks, 58 (35.8%) for more than two weeks, and 51 (31.5%) had no cough. Fever greater than 38°F was reported in 65 (40.1%) participants, while 61 (37.7%) had fever below 38°F, and 36 (22.2%) had no fever. Weight loss greater than 10% was noted in 149 (92.0%) participants, while only 13 (8.0%) had weight loss less than 10%. Night sweats were reported in 2 (1.2%) cases and absent in 160 (98.8%). Lymph node involvement was found in 14 (8.6%) participants, while 137 (84.7%) had no lymphadenopathy, and localized lymph node enlargement was seen in 11 (6.8%) participants. Hepatomegaly was observed in 14 (8.6%) participants, splenomegaly in 4 (2.5%), and no organomegaly in 144 (88.9%). Chest X-rays showed consistent findings in 55 (34.0%) participants, specific changes in 6 (3.7%), non-specific findings in 74 (45.7%), and no abnormality in 27 (16.7%). Gene Xpert testing revealed positive results in 52 (32.1%) participants and negative in 110 (67.9%) (**Table I**).

Compare clinical symptoms and characteristics with the presence of pulmonary tuberculosis (PTB). Among them, 63 (38.9%) were PTB positive and 99 (61.1%) were PTB negative. The mean age of PTB-positive participants was 17.67 ± 12.39 months, while that of PTB-negative participants was 17.29 ± 11.74 months, showing no significant difference (p = 0.847). Males accounted for 25 (32.9%) of the PTB-positive group and 51 (67.1%) of the PTB-negative group, whereas females comprised 38 (44.2%) of the PTB-positive and 48 (55.8%) of the PTB-negative participants (p = 0.141). Bilateral pitting oedema was observed in 7 (33.3%) PTB-positive and 14 (66.7%) PTB-negative cases, indicating no significant association (p = 0.576). Cough duration also showed no significant relationship with PTB status (p = 0.477). Among PTB-positive participants, 23 (43.4%) had a cough for less than two weeks, 19 (32.8%) for

more than two weeks, and 21 (41.2%) reported no cough. Fever patterns were comparable between groups (p = 0.201); 26 (42.6%) of PTB-positive participants had a temperature below 38°F, 20 (30.8%) above 38°F, and 17 (47.2%) had no fever. Weight loss greater than 10% was found in 57 (38.3%) PTB-positive and 92 (61.7%) PTB-negative participants, while weight loss less than 10% was seen in 6 (46.2%) PTB-positive and 7 (53.8%) PTB-negative participants (p = 0.575). Night sweats were rare and showed no significant difference between groups (p = 0.628). Lymph node involvement was more frequent among PTB-positive cases (9 [64.3%]) compared to PTB-negative (5 [35.7%]), with a p-value of 0.055, indicating a trend toward significance. Hepatomegaly was also more common among PTB-positive participants (9 [64.3%]) than PTB-negative ones (5 [35.7%]), but the difference was not statistically significant (p = 0.107). Chest X-ray findings showed no significant difference between groups (p = 0.770), with consistent changes noted in 22 (40.0%) PTB-positive and 33 (60.0%) PTB-negative participants, and non-specific findings in 26 (35.1%) PTB-positive and 48 (64.9%) PTB-negative individuals. Similarly, Gene Xpert results did not differ significantly between groups (p = 0.443), with 18 (34.6%) PTB-positive and 34 (65.4%) PTB-negative cases testing positive, while 45 (40.9%) PTB-positive and 65 (59.1%) PTB-negative cases tested negative (**Table II**).

Table I: Demographic and Clinical Characteristics of Study Participants (n=162)		
Mean ± Standard Deviation		**95% Confidence Interval**
Age in Months = **17.44 ± 11.96**		15.58---19.29
Weight in Kg = **4.90 ± 1.52**		4.66---5.14
Height in cm= **64.56 ± 8.56**		63.23---65.89
Mid Upper Arm Circumference = **9.54 ± 4.39**		8.86---10.22
SD = **-3.89 ± 0.37**		-3.95---3.83
Respiratory Rate = **34.13 ± 7.58**		32.95---35.31
Pakistan Paediatric Association = **5.57 ± 1.82**		5.29---5.86
Frequency (%)		
Gender	Male	76 (46.9)
	Female	86 (53.1)
BI Pitting oedema	Yes	21 (13.0)
	No	142 (87.0)
Cough Duration	<2Week	53 (32.7)
	>2Week	58 (35.8)
	No	51 (31.5)
Fever	>38 f	65 (40.1)
	<38 f	61 (37.7)
	No	36 (22.2)
Weight Loss	<10 %	13 (8.0)
	>10 %	149 (92.0)
Night sweats	Yes	2 (1.2)
	No	160 (98.8)
Lymph node	Yes	14 (8.6)
	No	137 (84.7)

	Localised	11 (6.8)
Hepatol spleen	Hepatomegaly	14 (8.6)
	Yes	4 (2.5)
	No	144 (88.9)
Chest Xray	Consistent	55 (34.0)
	Specific	6 (3.7)
	Non-Specific	74 (45.7)
	No	27 (16.7)
Gene Xpert	Positive	52 (32.1)
	Negative	110 (67.9)

Table II: Comparison of Clinical Symptoms & Characteristics with Pulmonary Tuberculosis (n=162)

Clinical Symptoms & Characteristics		**Pulmonary Tuberculosis**		**P-Value**
		Positive **(n=63)**	Negative **(n=99)**	
Age in Months		17.67 ± 12.39	17.29 ± 11.74	0.847
Gender	Male	25 (32.9)	51 (67.1)	0.141
	Female	38 (44.2)	48 (55.8)	
BI Pitting Idema	Yes	7 (33.3)	14 (66.7)	0.576
	No	56 (39.7)	85 (60.3)	
Cough Duration	<2 Week	23 (43.4)	30 (56.6)	0.477
	>2 Week	19 (32.8)	39 (67.2)	
	No Cough History	21 (41.2)	30 (58.8)	
Fever Status	<38f	26 (42.6)	35 (57.4)	0.201
	≥38f	20 (30.8)	45 (69.2)	
	Afebrile	17 (47.2)	19 (52.8)	
Weight Loss	<10%	6 (46.2)	7 (53.8)	0.575
	>10%	57 (38.3)	92 (61.7)	
Night Sweats	Yes	1 (50.0)	1 (50.0)	0.628
	No	62 (38.8)	98 (61.3)	
Lymph node	Yes	9 (64.3)	5 (35.7)	0.055
	No	48 (35.0)	89 (65.0)	
	Localised	6 (54.5)	5 (45.5)	

Hepatol/Spleen	Hepatomegaly	9 (64.3)	5 (35.7)	0.107
	Yes	2 (50.0)	2 (50.0)	
	No	52 (36.1)	92 (63.9)	
Chest Xray	Consistent	22 (40.0)	33 (60.0)	0.770
	Specific	3 (50.0)	3 (50.0)	
	Non-Specific	26 (35.1)	48 (64.9)	
	Not Performed	12 (44.4)	15 (55.6)	
Gene Xpert	Positive	18 (34.6)	34 (65.4)	0.443
	Negative	45 (40.9)	65 (59.1)	

DISCUSSION

This study examined the frequency and clinical characteristics of pulmonary tuberculosis (TB) among children aged 2–59 months with severe acute malnutrition (SAM) admitted to a tertiary care facility in Sukkur, Pakistan. The GeneXpert MTB/RIF assay detected TB in 32.1% of participants, indicating a substantial burden of disease in this nutritionally vulnerable group. The coexistence of TB and SAM is well recognized for its reciprocal impact: malnutrition weakens host immune defence, while TB further worsens nutritional status through chronic inflammation and metabolic stress [1–3].

The diagnostic criteria used in this study combined clinical, radiological, and molecular approaches in accordance with World Health Organization (WHO) and Pakistan Paediatric Association (PPA) recommendations [2,7]. Children were assessed for persistent cough, prolonged fever, marked weight loss, and the presence of lymphadenopathy or organomegaly. Although fever (77.8%) and significant weight loss (92.0%) were frequent, none of these symptoms showed a statistically significant association with TB positivity ($p > 0.05$). This finding aligns with results from Laghari et al. [7] and Chisti et al. [11], who found that classical TB symptoms
lose diagnostic specificity in severely malnourished children due to overlapping infections and diminished inflammatory responses. Franco et al. [3] also reported that the clinical presentation of TB in undernourished children is often atypical, contributing to diagnostic delays in low-resource settings.

The mean age of the study population (17.44 ± 11.96 months) closely corresponds with that reported by Khalil et al. [6], who observed a mean age of 18.5 ± 10.4 months in Pakistani children with SAM and suspected TB. The nearly equal gender distribution (46.9% male, 53.1% female) was also comparable to studies from Pakistan and Ethiopia, which noted a slightly higher TB frequency in females, possibly due to differences in healthcare access and nutritional deprivation [8,9]. Consistent with previous reports [7,9], no significant association was found between TB positivity and either age or gender, suggesting that risk is uniform across demographic subgroups of malnourished children.

In this study PTB was identified in 38.8% of the children examined, reflecting a notably higher prevalence than that documented by Kumar et al. [10] in India (8.9%) and Atalell et al. [9] in Ethiopia (10.7%). The finding, however, was comparable to the 36.9% reported by Khalil et al. [6] among Pakistani children. Differences observed across these studies likely arise from variations in diagnostic protocols, demographic characteristics, and the underlying endemicity of tuberculosis in each setting. Research that relies exclusively on clinical signs or chest radiography tends to report lower TB rates, whereas investigations employing molecular assays such as GeneXpert—used in the present study—achieve higher detection efficiency due to superior sensitivity and specificity [6,10,11].

Radiological evaluation revealed disease-consistent findings in 34.0% of participants, although no significant difference was observed between TB-

positive and TB-negative groups (p = 0.770). Comparable results were documented by Chisti et al. [11] and Munthali et al. [14], who highlighted that chest X-ray patterns in malnourished children frequently overlap with pneumonia or other respiratory infections, making radiographic diagnosis alone unreliable. Nevertheless, imaging remains a valuable supportive tool where microbiological confirmation is not readily available [7,11].

Lymphadenopathy (8.6%) and hepatomegaly (8.6%) were more common among TB-positive children, with lymph node enlargement approaching statistical significance (p = 0.055). These findings parallel those of Franco et al. [3] and Laghari et al. [7], who described lymphadenopathy as a relatively consistent feature of paediatric TB, especially among children with SAM. Hepatomegaly, while nonspecific, has been noted in disseminated or miliary TB, as reported in African cohorts [9,13]. Night sweats were rare (1.2%), reflecting the limited diagnostic value of this symptom in young or malnourished children, as observed in studies by Chisti et al. [11] and Munthali et al. [14].

The diagnostic yield of GeneXpert (32.1% positive) underscores its reliability in identifying TB among children with SAM, where conventional smear microscopy performs poorly due to paucibacillary disease. Comparable GeneXpert positivity rates have been reported by Khalil et al. [6] in Pakistan and Kumar et al. [10] in India, emphasizing the importance of molecular testing in improving diagnostic accuracy. These findings align with WHO recommendations advocating GeneXpert as a frontline test in paediatric TB, particularly among high-risk groups [2,17].

No significant relationship was identified between TB positivity and demographic or clinical variables in this study, a result consistent with the findings of Laghari et al. [7] and Atalell et al. [9]. This reinforces the need for a comprehensive diagnostic approach that integrates clinical evaluation with radiological and molecular investigations rather than reliance on individual signs or symptoms.

The high frequency of TB detected among severely malnourished children in this study reflects the ongoing intersection between infectious disease and undernutrition in low-resource settings. International evidence consistently supports that undernutrition remains one of the strongest modifiable risk factors for TB development and progression [1,3,12,13]. In Zambia, Munthali et al. [14] found increased mortality among malnourished children co-infected with TB, while meta-analyses by Vonasek et al. [1] and Franco et al. [3] confirmed that malnutrition markedly elevates the risk of active TB and relapse. The immunological compromise associated with SAM, particularly reduced T-cell function and altered cytokine response, provides a biological basis for this relationship [4,5].

Given these findings, it is essential that TB screening is systematically integrated into the management of malnourished children. The incorporation of GeneXpert into standard evaluation protocols can significantly enhance early detection and treatment outcomes, supporting WHO recommendations to strengthen combined TB and malnutrition programs in endemic regions[18,19].

CONCLUSION

This study identified pulmonary tuberculosis in about one-third of children with severe acute malnutrition, emphasizing the considerable overlap between these two conditions. No statistically significant association was observed between tuberculosis positivity and demographic or clinical characteristics, showing that symptoms alone cannot reliably guide diagnosis. Integrating molecular diagnostics such as the GeneXpert assay into nutrition rehabilitation services is essential to enable timely detection and improve treatment outcomes among malnourished children in high-burdenregions.

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