Section: Miscellaneous

Original Research Article

CORRELATION OF BASELINE IMAGING FINDINGS WITH TREATMENT RESPONSE IN CHILDREN WITH PULMONARY TUBERCULOSIS

Mothe Siddharth Reddy[1], Kuchana Suresh Kumar[2], Richa Dikshit[3]

[1]*Assistant Professor, Department of Pediatrics, Prathima Relief Institute of Medical Sciences, Warangal, Telangana, India.*
[2]*Assistant Professor, Department of Pediatrics, Prathima Relief Institute of Medical Sciences, Warangal, Telangana, India.*
[3]*Associate Professor, Department of Radiology, ESIC Medical College, Sanath Nagar, Hyderabad, India.*

Received *: 11/10/2025*
Received in revised form *: 02/12/2025*
Accepted *: 19/12/2025*

Corresponding Author:
Dr. Richa Dikshit,
Associate Professor, Department of Radiology, ESIC Medical College, Sanath Nagar, Hyderabad, India.
Email: richadikshit@hotmail.com

DOI: 10.70034/ijmedph.2025.4.530

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2025; 15 (4); 2957-2961

ABSTRACT

Background: Pediatric pulmonary tuberculosis (PTB) presents diagnostic and management challenges due to nonspecific clinical features and limited microbiological yield. Imaging plays a central role in disease assessment, yet the prognostic relevance of specific radiological findings in children remains incompletely understood. This study was undertaken to evaluate baseline imaging characteristics in children with pulmonary tuberculosis and determine their association with short-term clinical outcomes following anti-tubercular therapy.

Materials and Methods: Sixty-four children aged 1-18 years diagnosed with PTB were enrolled in an observational cohort. Baseline chest radiography and, when indicated, computed tomography was assessed for radiological severity and specific imaging features, including cavitation, bronchiectasis, miliary disease, and lymph node morphology. Clinical response at 6 months was categorized as good or poor based on symptomatic improvement and physician assessment. Chi-square testing examined associations between imaging parameters and outcome. Logistic regression identified independent imaging predictors of poor response.

Results: Mild radiological disease was most common (46.9%), followed by moderate (34.4%) and severe disease (18.7%). A good clinical response was observed in 62.5% of patients. Cavitation (37.5%), lymph node necrosis (40.6%), and bronchiectasis (20.3%) were observed with variable frequency. Although disease severity showed a trend toward poorer response, the association was not statistically significant (p=0.185). Logistic regression demonstrated that necrotic lymph node involvement independently predicted poor outcome (p=0.031), while cavitation and bronchiectasis were not significant predictors.

Conclusion: Radiological assessment provides valuable prognostic insight in pediatric PTB. Necrotic lymphadenopathy at baseline imaging may identify children at higher risk of delayed response, warranting closer monitoring and targeted follow-up strategies.

Keywords: Pediatric tuberculosis, Pulmonary TB, Imaging predictors, Lymph node necrosis, Clinical outcome.

INTRODUCTION

Pulmonary tuberculosis (TB) remains a major cause of morbidity and mortality in children, particularly in low- and middle-income countries. Recent global estimates suggest that children account for a substantial proportion of the 10 million annual TB cases, with a large diagnostic gap leading to under-recognition and preventable deaths.[1,2] The burden is greatest in young children and those with comorbidities such as HIV, in whom rapid progression and disseminated disease are common.[3] Diagnosing pulmonary TB in children is challenging because disease is typically paucibacillary and

respiratory samples are difficult to obtain; culture and molecular tests often have limited sensitivity. Consequently, clinicians frequently rely on a composite of epidemiological risk, clinical features and imaging findings to establish a diagnosis and to monitor response to therapy.[3,4] Chest radiography (CXR) is recommended as the initial imaging modality in suspected pediatric pulmonary TB and remains central to screening and follow-up in high-burden settings.[5,6] However, CXR has suboptimal sensitivity and inter-observer variability, particularly for detecting mediastinal and hilar lymphadenopathy, which is the radiologic hallmark of primary childhood TB.[6]

Cross-sectional imaging, especially computed tomography (CT), provides superior delineation of lymph node enlargement, necrosis, bronchial compression, parenchymal consolidation, cavitation and miliary nodules.[4,6] CT-based series have characterized typical enhancement patterns of tuberculous lymphadenopathy and documented regression in nodal size and change in morphology following antitubercular therapy.[7] Nonetheless, concerns regarding ionizing radiation, cost and limited availability restrict CT use in many resource-constrained settings, emphasizing the need to understand when CT-detected abnormalities carry prognostic significance.[5,6]

In adults, specific imaging features such as cavitation, extensive consolidation or miliary spread have been linked to higher bacillary burden, smear positivity and worse clinical outcomes, including treatment failure or relapse.[8,9] Pediatric literature, in contrast, is dominated by descriptive imaging studies, and robust data correlating baseline radiologic patterns with treatment response, complications or residual lung damage are scarce.[5,6]

Against this background, the present study aims to evaluate imaging findings in children with pulmonary TB on CXR and CT and to correlate these radiologic patterns with clinical outcomes. By identifying imaging features associated with adverse or favourable evolution, this work seeks to refine risk stratification, guide imaging follow-up, and support more individualized management strategies in pediatric pulmonary tuberculosis.

MATERIALS AND METHODS

This hospital-based observational cohort study was conducted in the collaboration of Department of Pediatrics with the Department of Radiodiagnosis at Prathima Relief Institute of Medical Sciences from June 2024 to October 2025. Written informed consent was collected from parents or legal guardians of all participants after obtaining approval from the institutional ethics committee. A total of 64 pediatric cases aged between 1 to 18 years who are clinically diagnosed or suspected to have pulmonary tuberculosis (PTB) were recruited.

Inclusion Criteria: Children aged 1-18 years diagnosed with pulmonary tuberculosis based on microbiological confirmation and persistent cough >2 weeks, fever, weight loss, and a positive tuberculin skin test or interferon gamma release assay along with radiological evidence suggestive of PTB, cases who underwent chest imaging at baseline, and availability of follow-up clinical outcome data at 3 to 6 months.

Exclusion Criteria: Cases with known congenital lung anomalies, cystic fibrosis, bronchopulmonary dysplasia, HIV, malignancy receiving chemotherapy, Incomplete imaging records and lost to follow-up.

Baseline demographic information, clinical features, nutritional status, BCG vaccination status, laboratory parameters, and microbiological test results were recorded. Patients received anti-tubercular therapy (ATT) as per national TB treatment guidelines. Clinical outcome at follow-up was categorized as good response with complete or significant improvement of symptoms and poor response with persistent or worsening symptoms, treatment failure, need for regimen modification.

Standard posteroanterior (PA) view chest X-ray was taken in cooperative children; anteroposterior (AP) view was used for younger or non-ambulatory children. High-Resolution Computed Tomography (HRCT) was performed in selected cases with inconclusive radiographs or severe disease. Imaging was acquired using a 64-slice multidetector CT scanner with low-dose pediatric protocol. Two radiologists with more than 3 years of pediatric imaging experience independently reviewed the images while blinded to clinical outcomes. Discrepancies were resolved by consensus. Radiological severity was graded as mild, moderate, or severe based on extent of parenchymal involvement and lymphadenopathy.

The primary objective was to correlate baseline imaging features with clinical outcome at follow-up. Specific imaging characteristics were analysed to identify predictors of poor treatment response.

Statistical Analysis: The collected data was analysed using SPSS v.26.0 (IBM Corp., USA). Categorical variables were expressed as frequency and percentage, while continuous variables were presented as mean and standard deviation. Chi-square test was used for comparison of categorical variables. Mann–Whitney U test was applied for continuous variables depending on distribution. Logistic regression analysis was performed to determine imaging predictors of poor clinical outcome. A p-value < 0.05 was considered statistically significant.

RESULTS

Table 1: Demographic and clinical characteristics of study participants (n = 64)

Category	Total cases (n=64)
	Frequency (%)
Age (range 1–18 years)	10.1 ± 4.7
Gender	
Male	35 (54.7%)
Female	29 (45.3%)
BCG vaccination status	
Vaccinated	48 (75.0%)
Unvaccinated	16 (25.0%)
Clinical presentation	
Chronic cough (>2 weeks)	64 (100%)
Fever	55 (85.9%)
Weight loss/failure to thrive	41 (64.0%)
Microbiological positivity	
GeneXpert/Microscopy/Culture	36 (56.2%)

Table 2: Association of imaging severity with clinical outcome

Severity	Good Response		Poor Response	
	Frequency	Percentage	Frequency	Percentage
Mild	24	80%	6	20%
Moderate	12	54.5%	10	45.5%
Severe	4	33.3%	8	66.7%
Total	40	62.5%	24	37.5%

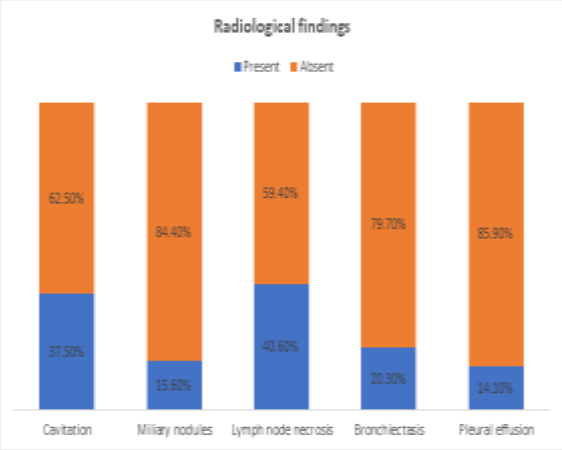
Table 3: Correlation of key imaging features with clinical outcome

Imaging Feature	Good Response	Poor Response	Interpretation
	Frequency (%)	Frequency (%)	
Cavitation present	13 (54.2%)	11 (45.8%)	Worse prognosis
Cavitation absent	27 (67.5%)	13 (32.5%)	Better prognosis
With lymph node necrosis	14 (53.8%)	12 (46.2%)	Associated with poor outcome trend
Bronchiectasis present	6 (46.2%)	7 (53.8%)	Strong predictor of poor outcome
Miliary disease present	4 (40.0%)	6 (60.0%)	Suggests disseminated disease

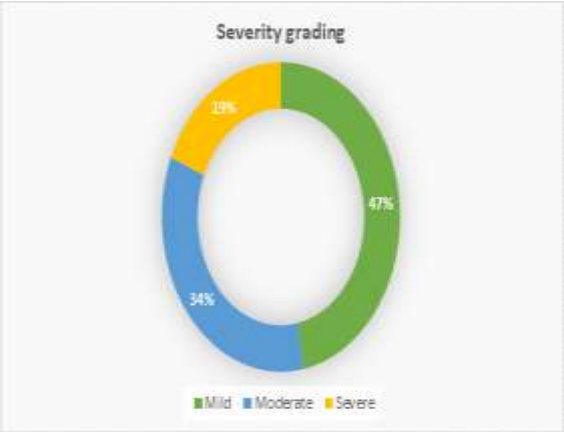
Table 4: Logistic regression analysis to identify imaging predictors of poor treatment response

Predictor	Coefficient (β)	Standard Error	p-value	Odds Ratio	95% CI
Cavitation	0.445	0.637	0.484	1.56	0.45 – 5.43
Lymph node necrosis	-1.83	0.847	0.031	0.16	0.03 – 0.84
Bronchiectasis	0.788	0.718	0.272	2.20	0.54 – 9.00

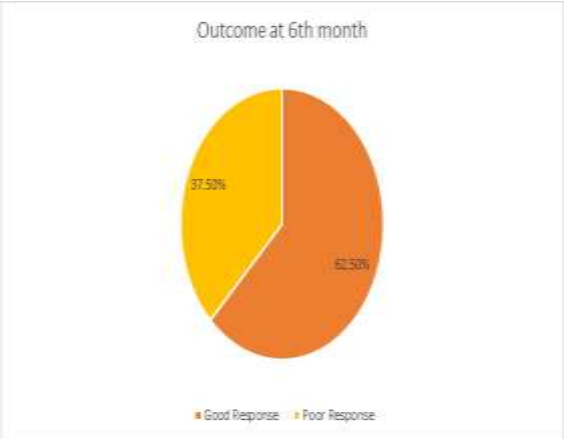
Logistic regression analysis identified lymph node necrosis as an independent predictor of poor treatment response (β=-1.83, OR=0.16, 95% CI: 0.03–0.84, p=0.031). Other imaging features including cavitation and bronchiectasis did not reach statistical significance. The regression model demonstrated a trend toward significance (LLR p=0.069), indicating potential predictive value with a larger cohort.



Graph 1: Distribution of radiological imaging findings (n = 64)



Graph 2: Radiological severity grading (n = 64)



Graph 3: Clinical outcomes at 6-month follow-up

DISCUSSION

The present study evaluated the relationship between baseline imaging findings and short-term clinical outcome in children with pulmonary tuberculosis (PTB). In our cohort, most children had mild to moderate radiological disease, and nearly two-thirds showed good clinical response to anti-tubercular therapy. However, necrotic lymph node involvement on imaging independently predicted poor outcome on logistic regression, whereas cavitation and bronchiectasis did not retain significance. These findings highlight the prognostic value of careful lymph node assessment in pediatric chest imaging.

Chest imaging remains central to the diagnosis and staging of PTB in children because microbiological confirmation is often difficult and insensitive in this age group.[1] CT, in particular, is regarded as the cross-sectional reference standard for detecting mediastinal lymphadenopathy, airway compression, and early parenchymal complications, while radiographs continue to be the first-line screening tool owing to wide availability and lower radiation dose.[6,11] Our observation that the majority of children had lymph node–predominant disease with variable parenchymal involvement mirrors the established pattern of primary pediatric TB, in which hilar and mediastinal adenopathy is the radiological hallmark and may be present in over 80–90% of cases.[6,12]

Recent multicentre work has emphasized both the indispensability and the limitations of chest radiography. Hernanz-Lobo et al. showed that, even when interpreted by expert readers, CXR has modest sensitivity but good specificity for pediatric TB, reinforcing the need to integrate imaging with clinical and microbiological data.[11] Systematic reviews of imaging modalities confirm that CT and MRI provide higher diagnostic accuracy than CXR for key PTB features such as lymphadenopathy, tree-in-bud nodules and cavitation, but at the cost of greater complexity, expense and, for CT, radiation exposure.[4,12] Our study used both CXR and CT according to clinical indication, reflecting real-world practice in many resource-constrained tertiary centres and underscoring how prognostic information can still be extracted from routinely acquired studies.

Several CT-based series have detailed the spectrum of pulmonary and nodal abnormalities in children with TB. Kim et al. and Peng et al. described frequent combinations of lymphadenopathy, consolidation, bronchogenic spread and occasional cavitation, particularly in infants and young children.[13,14] Mukund et al. further classified nodal patterns, noting that heterogeneous or rim-enhancing nodes are common and may be associated with adjacent airway narrowing and lobar collapse.[7] Our finding that necrotic (presumably caseating) lymph nodes were independently associated with poor short-term clinical response is consistent with the concept that more advanced nodal disease reflects higher mycobacterial burden and greater airway compromise. Similar links between bulky nodal disease and more severe clinical presentation have been reported in pediatric cohorts, although earlier work focused on diagnostic rather than prognostic endpoints.[7,15]

Interestingly, Uçar et al. demonstrated that while mediastinal lymphadenopathy is highly prevalent in both TB and community-acquired pneumonia, CT features may overlap, and lymph node size rather than morphology is more discriminative between the two entities.[15] Our results extend these observations by suggesting that, among children already diagnosed with TB, qualitative nodal features such as necrosis can help stratify those at risk of suboptimal early response. In adults, an older AJR study found that mediastinal nodal necrosis did not significantly affect long-term survival or treatment response, highlighting potential differences in disease biology and host response between adults and children.[8]

Cavitation and bronchiectasis are traditionally regarded as markers of high bacillary load and chronic structural damage, respectively. Comprehensive imaging reviews and guidelines emphasize that cavitation is more typical of post-primary TB, whereas in children bronchiectasis is often a late consequence of inadequately treated infection or recurrent suppurative disease.[6,16] In our cohort, cavitation and bronchiectasis showed a trend

toward poorer outcome on unadjusted analysis but were not independent predictors on multivariable logistic regression. This may reflect the relatively small number of children with these advanced changes, early initiation of therapy in a tertiary setting, and the fact that our outcome was short-term clinical response rather than long-term lung function. Nevertheless, the presence of bronchiectasis in any child with TB should prompt close follow-up, given evidence that early recognition and aggressive management can modify the trajectory of pediatric bronchiectasis.[16]

Our results also reinforce the broader principle that imaging findings must be interpreted in the context of clinical status. Reviews by Nel et al. and Nachiappan et al. stress that radiological "activity" does not always equate to microbiological activity, and that residual lymphadenopathy or parenchymal opacities may persist despite adequate treatment and clinical improvement.[6,17] In our study, a substantial proportion of children with moderate radiological severity still achieved good clinical response, suggesting that imaging alone should not drive decisions to prolong or intensify therapy in the absence of persistent symptoms or microbiological evidence of failure.

CONCLUSION

This study highlights the prognostic significance of imaging findings in pediatric pulmonary tuberculosis. Most children showed good clinical response to therapy; however, necrotic lymph node involvement on baseline imaging independently predicted poorer short-term outcomes, emphasizing the importance of detailed nodal evaluation. Although cavitation and bronchiectasis were associated with more advanced disease, they did not independently influence treatment response in this cohort. These results suggest that nodal morphology may serve as an important marker for early risk stratification. Larger longitudinal studies are needed to confirm these observations and evaluate the long-term clinical impact of imaging-based prognostic indicators in childhood tuberculosis.

REFERENCES

1. Liang Y, Wang J, Yang J, Liu J and He X (2025) Global burden and trend of tuberculosis in children and adolescents (under 15 years old) from 1990 to 2021, with projections to 2040. Front. Public Health. 13:1578658.
2. Salazar-Austin N, Cranmer LM. The underestimated burden of tuberculosis in children. Lancet Child Adolesc Health. 2024;8(12):845-847.
3. Mahomed N, Kilborn T, Smit EJ, Chu WCW, Young CYM, Koranteng N, Kasznia-Brown J, Winant AJ, Lee EY, Sodhi KS. Tuberculosis revisted: classic imaging findings in childhood. Pediatr Radiol. 2023 Aug;53(9):1799-1828.
4. Buonsenso D, Pata D, Visconti E, Cirillo G, Rosella F, Pirronti T, Valentini P. Chest CT Scan for the Diagnosis of Pediatric Pulmonary TB: Radiological Findings and Its Diagnostic Significance. Front Pediatr. 2021 Apr 23;9:583197.
5. Skoura E, Zumla A, Bomanji J. Imaging in tuberculosis. Int J Infect Dis. 2015;32:87-93.
6. Nel M, Franckling-Smith Z, Pillay T, Andronikou S, Zar HJ. Chest Imaging for Pulmonary TB—An Update. Pathogens. 2022; 11(2):161.
7. Mukund A, Khurana R, Bhalla AS, Gupta AK, Kabra SK. CT patterns of nodal disease in pediatric chest tuberculosis. World J Radiol. 2011;3(1):17-23.
8. Nachiappan AC, Rahbar K, Shi X, et al. Pulmonary Tuberculosis: Role of Radiology in Diagnosis and Management. Radiographics. 2017;37(1):52-72.
9. Wetscherek MTA, Sadler TJ, Lee JYJ et al. Active pulmonary tuberculosis: something old, something new, something borrowed, something blue. Insights Imaging. 2022; 13 (3):1-13.
10. Marais BJ, Gie RP, Schaaf HS et al. Childhood pulmonary tuberculosis: old wisdom and new challenges. Am J Respir Crit Care Med. 2006; 173:1078-1090.
11. Hernanz-Lobo A, et al. Diagnostic performance of chest radiography for pediatric tuberculosis across high- and low-burden settings. Front Pediatr. 2025;13:1704149.
12. Tonne EO, Erle O, et al. Imaging modalities for pulmonary tuberculosis in children: A systematic review. Eur J Radiol Open. 2022;10:100472.
13. Peng SS, Chan PC, Chang YC, Shih TT. Computed tomography of children with pulmonary Mycobacterium tuberculosis infection. J Formos Med Assoc. 2011;110(12):744-9.
14. Kim WS, Choi JI, Cheon JE, et al. Pulmonary tuberculosis in infants: radiographic and CT findings. AJR Am J Roentgenol. 2006;187(4):1024-33.
15. Uçar AK, Yazici Z, Yeşil E, et al. Diagnostic Value of Mediastinal Lymphadenopathy in Differentiating Pulmonary Tuberculosis from Community-Acquired Pneumonia in Children. Innov J Pediatr. 2022;32(4):e119235.
16. Chang AB, Fortescue R, Grimwood K, et al. European Respiratory Society guidelines for the management of children and adolescents with bronchiectasis. Eur Respir J. 2021;58(2):2002990.
17. Hopper KD, et al. The significance of necrotic mediastinal lymph nodes on CT in patients with thoracic malignancy or infection. AJR Am J Roentgenol. 1990;155(2):269-72.