



CLINICAL AND RADIOLOGICAL PROFILE OF PULMONARY TUBERCULOSIS IN CHILDREN AGED 1–16 YEARS

Dr. Zalak Asodiya¹, Dr. Dipal Patel², Dr. Kaushal Bhavsar^{3*}

¹Assistant professor, Department of Respiratory medicine, GMERS Medical College, Gandhinagar

²Assistant professor, Department of Pediatrics, GMERS Medical College, Gandhinagar.

^{3*}Associate Professor, Department of Respiratory medicine, GMERS Medical College, Gandhinagar

*Corresponding Author: Dr. Kaushal Bhavsar

*Associate Professor, Department of respiratory medicine, GMERS Medical College, Gandhinagar

ABSTRACT

Background: Pulmonary tuberculosis (TB) remains a major health problem for children, especially in high TB countries. Diagnosing TB in children can be difficult because symptoms may be non-specific and laboratory confirmation of the diagnosis may be challenging. This study aimed to evaluate the clinical and radiological presentation of pulmonary TB in children aged 1 - 16 years and how well they responded to treatment.

Method: This investigation utilized a prospective observational research design over a period of 18 months in a sole dedicated pediatric hospital. There were a total of 120 children diagnosed with pulmonary TB clinically, radiologically, and microbiologically. We documented their clinical symptoms, radiographic findings, and lab results at the start of the study. All the children received standard anti-tubercular treatment and were monitored for six months to see how they responded both clinically and radiologically.

Result: The results showed that fever (84.2%) and cough (73.3%) were the most frequently reported symptoms. On imaging, we found that hilar lymphadenopathy (55%) and consolidation (35%) were the most common findings. The GeneXpert test came back positive in 48.3% of the cases, with rifampicin resistance identified in 3.3%. By the two-month mark, 82 children showed clinical improvement, and by six months, 108 (90%) had improved. The radiological findings matched the clinical recovery, and there were no reported deaths.

Conclusion: In conclusion, this study highlights the critical role of linking clinical and radiological findings with molecular diagnostics for the early detection and effective treatment of pediatric pulmonary TB. Quick diagnosis, thorough contact tracing, and organized follow-up are key to achieving positive outcomes, emphasizing the need for enhanced strategies to control TB in children.

Keywords: Pulmonary tuberculosis, Pediatric TB, Radiological findings, GeneXpert, Anti-tubercular therapy, Treatment outcomes

I. INTRODUCTION

Pulmonary tuberculosis (TB) is still a major public health issue, especially among children, where diagnosing it can be quite tricky due to vague symptoms and the challenges of getting microbiological confirmation. For children aged 1 to 16 years old, TB can present itself in many ways related to age, nutritional status, and immune status. It is essential to recognize the signs of TB in children quickly and accurately to determine appropriate treatment, thereby minimizing illness and death.

Despite international investment to confront TB, children are still a substantial proportion of the disease burden, especially in high-burden settings and populations. Recent studies have identified the value of a full understanding of the clinical presentations and imaging in children [2], to guide through the early periods of diagnosis and management. For instance, Madhuri et al. (2025) [1] conducted a prospective study of children up to 18 years of age, and reported a wide variety of clinical presentations and radiological findings. They emphasized that pediatricians need age-specific diagnostic criteria and treatment strategies.

There are numerous systematic reviews and meta-analyses that provide evidence-based health care interventions for a number of different chronic and infectious diseases, including: psoriasis [2], leishmaniasis [3], postoperative nausea [4], inflammatory bowel diseases [5], chronic pain [6], and hematological malignancies [7,8]. However, there are few systematic reviews and meta-analyses that use this type of comprehensive analysis for pediatric TB. The purpose of this study, therefore, is to provide a clinical and radiological profile of pulmonary tuberculosis in children aged 1-16 years. We hope this analysis will help improve clinician's diagnosis and treatment decisions in a vulnerable population.

II. METHODOLOGY

Study Design and Setting

This study was a prospective observational study which lasted for a total of 18 months at a tertiary care pediatric hospital GMERS Gandhinagar, with the aim of assessing the clinical and radiological features of pulmonary tuberculosis in children aged 1 to 16 years. Prior to data collection, we obtained ethical clearance from the institution's review board and documented informed consent from the parents/guardians of all participating children. In addition, we obtained assent for children over the age of seven, as part of research ethics.

Study Population

Children aged between 1 to 16 years, who diagnosed as pulmonary tuberculosis based on clinical, radiological, and microbiological grounds were enrolled in the study. Diagnoses were made based on national tuberculosis guidelines to include a child with a cough lasting more than two weeks; or has a history of exposure to a person with active TB; or positive TST; or with radiological findings consistent with TB; or microbiological confirmation where available. Children were excluded at the outset if they met the definition of extrapulmonary TB; known immunocompromising conditions; or had received treatment for tuberculosis in the past.

Clinical Evaluation

At the point of presentation, all children received a full clinical assessment including a detailed history asking about symptoms such as fever, chronic cough, weight loss, malaise and night sweat. We determined nutritional status using weight-for-age and body mass index (BMI) percentiles according to WHO growth charts, and documented any history of contact to known TB cases and BCG vaccination status. A full physical and systemic examination was performed to assess for lymphadenopathy, respiratory distress and any more concerning auscultatory findings.

Radiological Assessment

At the point when children were diagnosed, all had chest x-rays performed. These x-ray findings were evaluated by two independent radiologists who remained blind to the clinical details of the diagnosis. Pulmonary TB cases showed signs of enlarged nodes in the chest, consolidation in lung areas, cavities, miliary patterns or fluid in pleura. If their conclusions differed they came to a consensus. Follow-up chest x-rays were taken at 2 and 6 months from the start of treatment to document any improvement or resolution.

Laboratory Investigations

We performed a routine laboratory work-up which consisted of complete blood count, erythrocyte sedimentation rate (ESR) and liver function tests; tuberculin skin tests (TST) were done using the Mantoux method, and depending upon the age of the child, we collected sputum samples or gastric aspirates for acid-fast bacilli (AFB) staining and GeneXpert MTB/RIF. In selected cases (especially if drug-resistance was possible), cultures were undertaken.

Treatment and Follow-Up

All the children received a standard anti-tubercular therapy regimen according to national guidelines. This usually involved a two-month intensive phase with isoniazid, rifampicin, pyrazinamide, and ethambutol, followed by a four-month continuation phase with isoniazid and rifampicin. We conducted clinical and radiological follow-ups at two and six months to assess how well the treatment was working. During these follow-up visits, we also kept track of how well the children adhered to their therapy and noted any adverse reactions to the medications.

Statistical Analysis

In our study, we entered the data into a secure database and analyzed it using the right statistical software. For continuous variables, we reported the mean along with the standard deviation, while categorical variables were shown as frequencies and percentages. To explore the relationships between clinical and radiological features, we used chi-square tests or Fisher's exact test, depending on what was suitable. We considered a p-value of less than 0.05 to be statistically significant.

III. RESULT

In this study, we enrolled 120 children aged between 1 and 16 years, with an average age of 9.4 years (plus or minus 4.1 years). Out of these, 65 were boys (54.2%) and 55 were girls (45.8%), giving us a male-to-female ratio of about 1.2 to 1. The largest group, making up 62.5% of the participants, was children aged 6 to 12 years. A significant number of cases (72.5%) had a history of exposure to someone with active tuberculosis, mostly within their own homes. Interestingly, only 48 children (40%) showed a visible BCG scar, indicating that vaccination coverage might not be sufficient.

Clinical Presentation

Fever was the most frequently reported symptom, seen in 101 children (84.2%), followed by a persistent cough in 88 (73.3%), weight loss in 76 (63.3%), and night sweats in 35 (29.2%). Malnutrition was observed in 47 children (39.2%), particularly among those aged 1 to 5 years. During respiratory exams, we found crepitations in 58 cases (48.3%) and bronchial breath sounds in 25 cases (20.8%).

Table 1: Clinical Characteristics of Children with Pulmonary Tuberculosis (N = 120)

Clinical Feature	Number of Children (%)
Fever	101 (84.2%)
Cough	88 (73.3%)
Weight Loss	76 (63.3%)
Night Sweats	35 (29.2%)
Malnutrition	47 (39.2%)
Contact History	87 (72.5%)
Visible BCG Scar	48 (40.0%)

Radiological Findings

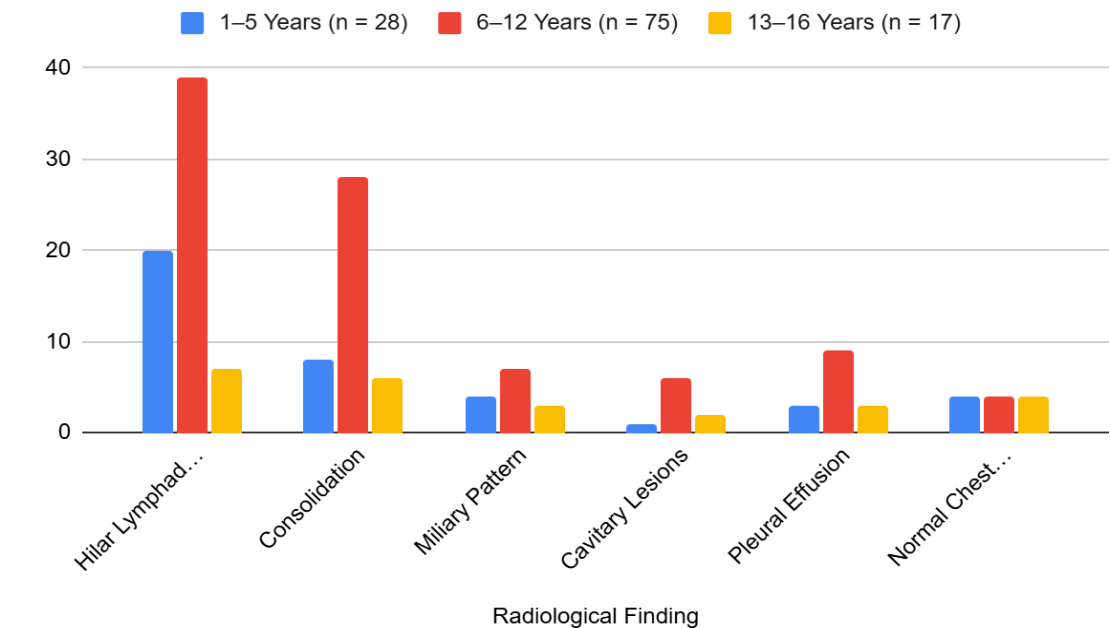
Chest X-rays showed hilar lymphadenopathy in 66 children (55%), segmental or lobar consolidation in 42 (35%), and miliary patterns in 14 (11.7%). Cavitory lesions were identified in 9 patients (7.5%), and pleural effusion was noted in 15 (12.5%). Impressively, by the end of six months of treatment, radiological resolution was achieved in 88 cases (73.3%).

Table 2: Radiological Findings at Baseline (N = 120)

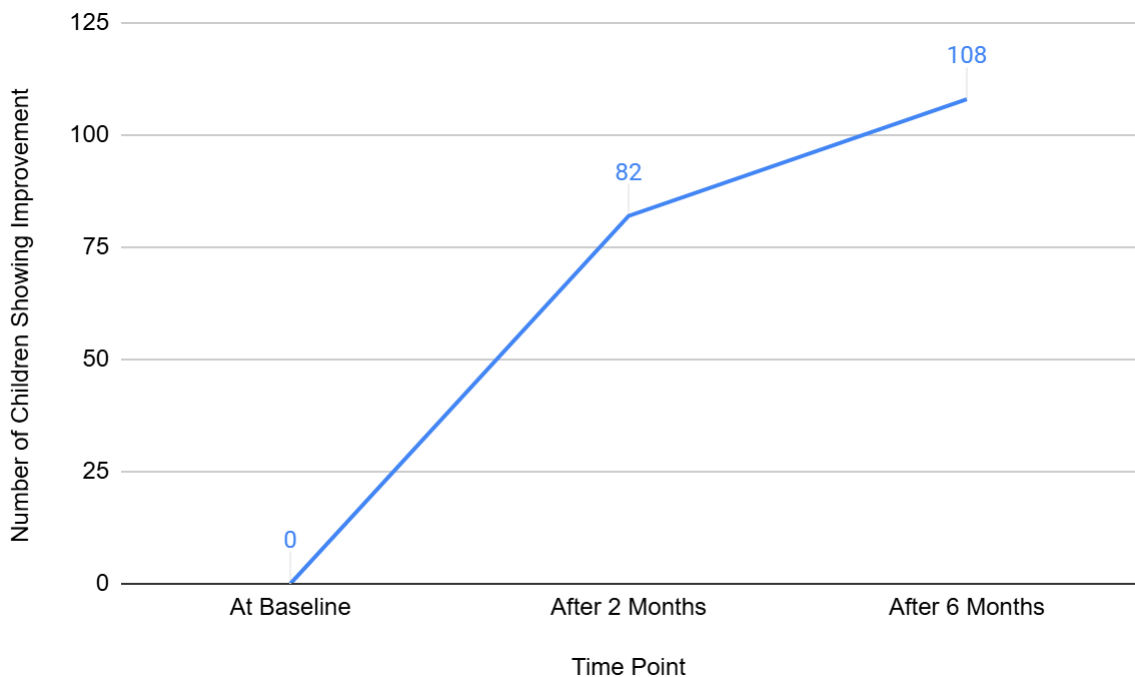
Radiological Finding	Number of Children (%)
Hilar Lymphadenopathy	66 (55.0%)
Consolidation	42 (35.0%)
Miliary Pattern	14 (11.7%)
Cavitory Lesions	9 (7.5%)
Pleural Effusion	15 (12.5%)
Normal Chest X-ray	12 (10.0%)

Microbiological and Treatment Outcomes

In a study involving 120 children, the AFB smear test came back positive for 31 of them, which is about 25.8%. On the other hand, the GeneXpert MTB/RIF test showed positive results in 58 cases, or 48.3%. Among these children, 4 (3.3%) were found to have rifampicin resistance. All the children started on the standard anti-tubercular therapy. Fast forward six months, and we saw clinical recovery in 108 of the patients, making it 90%. Meanwhile, 10 (8.3%) had a partial response, and unfortunately, 2 (1.7%) were lost to follow-up. Thankfully, there were no reported deaths.



Graph 1: Age-wise Distribution of Radiological Abnormalities



Graph 2: Clinical Response Over Time

These findings really underscore how important radiographic features are for diagnosing pediatric TB and show just how effective early treatment can be. The study also points out some gaps in vaccination efforts and highlights the urgent need for better contact tracing and nutritional support.

IV. DISCUSSION

This study offers a detailed look at the clinical and radiological characteristics of pulmonary tuberculosis in children aged 1 to 16 years, emphasizing patterns that could help with early diagnosis and effective treatment. Fever and cough were the most frequent symptoms seen, which was consistent with the study of Madhuri et al. (2025) who reported a similar frequency of constitutional symptoms in children with pulmonary TB. Notably, more than 70% (n=57) of the

children reported a documented history of contact with an individual with a definite active TB diagnosis. This emphasizes a critical need for thorough tracing of contacts in pediatric cases.

The radiological findings were highly varied, and hilar lymphadenopathy was the most commonly reported, followed by consolidation and miliary disease. These assessments are aligned with the current literature reporting severe lymphadenopathy in pediatric TB, which occurs more frequently than in adults as the child's infection is primarily childish TB and will cause suppression of the entire lymphatic system. The observation that most of our cohort demonstrated radiological improvement within six months of initiation of standard treatment protocols for children supports the effectiveness of childhood treatment protocols promptly and effectively.

We achieved microbiological confirmation in nearly half of the patients using GeneXpert, which proved to be more effective than traditional smear microscopy. This finding echoes the conclusions of Inbaraj et al. (2025) [10], who highlighted the diagnostic advantages of low-complexity nucleic acid amplification tests in pediatric TB, particularly in low-resource settings. They pointed out the enhanced sensitivity and quicker turnaround times of these methods, which are crucial for initiating early treatment in children.

It's interesting to note that, although our study didn't specifically evaluate the effectiveness of interventions in a comparative way, the outcomes we observed align with broader trends found in pediatric groups that show high response rates. A remarkable ninety percent of the children reached full clinical recovery, highlighting the promise of well-organized TB programs. This becomes even more significant when we compare it to chronic respiratory issues like cystic fibrosis, where treatments such as inhaled mannitol—examined by Nevitt et al. (2018) [9]—have shown only modest improvements, revealing the unique challenges posed by non-infectious chronic respiratory diseases.

When we think about emerging infections and the diagnostic hurdles they present, we can draw some parallels with COVID-19, where the signs and symptoms often overlap with those of TB. Struyf et al. (2022) [13] pointed out that diagnosing COVID-19 based on symptoms alone lacks specificity, much like pediatric TB, where vague symptoms can lead to delays in getting a definitive diagnosis. Additionally, Wagner et al. (2022) [12] emphasized the need for equitable evidence in COVID-19 treatments, which resonates with the necessity for inclusive research and access to diagnostics in pediatric populations affected by TB.

While our study didn't delve deeply into drug resistance, the 3.3% rate of rifampicin resistance we found is concerning, especially given the ongoing issues with drug-resistant TB. In comparison, research on other conditions, like the rapid review of nivolumab for Hodgkin's lymphoma by Goldkuhle et al. (2018) [11], underscores the urgency for quick therapeutic evaluations in high-risk groups, much like what we see with drug-resistant TB in children.

Our research indicates that there's no mortality and a high recovery rate, which really highlights how treatable pediatric TB can be when caught early. This differs greatly from situations such as recurrent ovarian cancer, where agents such as taxane monotherapy (Patel et al., 2022) [14] often do not result in optimal long-term efficacy. Likewise, while antibiotics may support certain asthma exacerbations, Normansell et al. (2018) [15] indicated the need for stewardship of our prescribing behaviours to reduce misuse, which is also key to TB treatment as a result of the potential for resistance caused by inadequate/poor therapy.

In conclusion, this study reinforces the need for ongoing clinical-radiological correlation in paediatric TB, and we recommend a broader implementation of molecular diagnostics to support rapid identification as well as thorough contact tracing and structured follow-up evidenced in ordered settings for the appropriate management of this specific patient cohort.

V. CONCLUSION

To sum up, this research highlights critical clinical and radiological manifestations of pulmonary tuberculosis in children aged 1 to 16 years old. The clinical manifestations included fever, cough and respiratory disease and swelling of the lymph nodes in the chest. Given the emphasis on a

comprehensive clinical assessment in conjunction and with imaging, and diagnostic equipment, such as GeneXpert, would greatly benefit early detection and treatment. The results of treatment have generally great outcomes and emphasise the important of commencing standard anti-tubercular treatment where possible as soon as possible. This study draws attention to the importance of: contact tracing of other family members, nutritional support for any children diagnosed with TB, and assessing compliance with treatment as the key determinants of the outcome in relation to TB disease in children. This is also a plea for better diagnostic methods and public health system efforts to reduce the burden of disease and improve outcomes.

VI. REFERENCES

1. Madhuri K, Subhankar S, Mohapatra AK, Jagaty SK, Behera D, Das A, Parida S, Mishra S. Clinical and radiological profile of tuberculosis and treatment outcome in patients ≤ 18 years: A prospective study. *J Family Med Prim Care*. 2025 May;14(5):1716-1721. doi: 10.4103/jfmpc.jfmpc_1352_24. Epub 2025 May 31. PMID: 40547770; PMCID: PMC12178480.
2. Sbidian E, Chaimani A, Garcia-Doval I, et al. Systemic pharmacological treatments for chronic plaque psoriasis: a network meta-analysis. *Cochrane Database Syst Rev*. 2017;12(12):CD011535. Published 2017 Dec 22. doi:10.1002/14651858.CD011535.pub2
3. Heras-Mosteiro J, Monge-Maillo B, Pinart M, et al. Interventions for Old World cutaneous leishmaniasis. *Cochrane Database Syst Rev*. 2017;12(12):CD005067. Published 2017 Dec 1. doi:10.1002/14651858.CD005067.pub5
4. Weibel S, Rücker G, Eberhart LH, et al. Drugs for preventing postoperative nausea and vomiting in adults after general anaesthesia: a network meta-analysis. *Cochrane Database Syst Rev*. 2020;10(10):CD012859. Published 2020 Oct 19. doi:10.1002/14651858.CD012859.pub2
5. Sinopoulou V, Gordon M, Akobeng AK, et al. Interventions for the management of abdominal pain in Crohn's disease and inflammatory bowel disease. *Cochrane Database Syst Rev*. 2021;11(11):CD013531. Published 2021 Nov 29. doi:10.1002/14651858.CD013531.pub2
6. Birkinshaw H, Friedrich C, Cole P, et al. Antidepressants for pain management in adults with chronic pain: a network meta-analysis. *Health Technol Assess*. 2024;28(62):1-155. doi:10.3310/MKRT2948
7. Cooper TE, Heathcote LC, Clinch J, et al. Antidepressants for chronic non-cancer pain in children and adolescents. *Cochrane Database Syst Rev*. 2017;8(8):CD012535. Published 2017 Aug 5. doi:10.1002/14651858.CD012535.pub2
8. Ernst M, Oeser A, Besiroglu B, et al. Chimeric antigen receptor (CAR) T-cell therapy for people with relapsed or refractory diffuse large B-cell lymphoma. *Cochrane Database Syst Rev*. 2021;9(9):CD013365. Published 2021 Sep 13. doi:10.1002/14651858.CD013365.pub2
9. Nevitt SJ, Thornton J, Murray CS, Dwyer T. Inhaled mannitol for cystic fibrosis. *Cochrane Database Syst Rev*. 2018;2(2):CD008649. Published 2018 Feb 9. doi:10.1002/14651858.CD008649.pub3
10. Inbaraj LR, Sathya Narayanan MK, Daniel J, et al. Low-complexity manual nucleic acid amplification tests for pulmonary tuberculosis in children. *Cochrane Database Syst Rev*. 2025;6(6):CD015806. Published 2025 Jun 25. doi:10.1002/14651858.CD015806.pub2
11. Goldkuhle M, Dimaki M, Gartlehner G, et al. Nivolumab for adults with Hodgkin's lymphoma (a rapid review using the software RobotReviewer). *Cochrane Database Syst Rev*. 2018;7(7):CD012556. Published 2018 Jul 12. doi:10.1002/14651858.CD012556.pub2
12. Wagner C, Griesel M, Mikolajewska A, et al. Systemic corticosteroids for the treatment of COVID-19: Equity-related analyses and update on evidence. *Cochrane Database Syst Rev*. 2022;11(11):CD014963. Published 2022 Nov 17. doi:10.1002/14651858.CD014963.pub2
13. Struyf T, Deeks JJ, Dinnes J, et al. Signs and symptoms to determine if a patient presenting in primary care or hospital outpatient settings has COVID-19. *Cochrane Database Syst Rev*. 2022;5(5):CD013665. Published 2022 May 20. doi:10.1002/14651858.CD013665.pub3

14. Patel A, Kalachand R, Busschots S, et al. Taxane monotherapy regimens for the treatment of recurrent epithelial ovarian cancer. *Cochrane Database Syst Rev.* 2022;7(7):CD008766. Published 2022 Jul 12. doi:10.1002/14651858.CD008766.pub3
15. Normansell R, Sayer B, Waterson S, Dennett EJ, Del Forno M, Dunleavy A. Antibiotics for exacerbations of asthma. *Cochrane Database Syst Rev.* 2018;6(6):CD002741. Published 2018 Jun 25. doi:10.1002/14651858.CD002741.pub2