



## Radiological Spectrum of Pulmonary Tuberculosis in Paediatric and Adult Patients in a Tertiary Care Centre

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### ABSTRACT

**Background:** Pulmonary tuberculosis remains a major public health problem in developing countries and shows varied radiological manifestations across different age groups. Radiological imaging plays a vital role in early diagnosis and assessment of disease extent, especially when microbiological confirmation is delayed.

**Objectives:** To evaluate and compare the radiological spectrum of pulmonary tuberculosis in paediatric and adult patients attending a tertiary care centre.

**Materials and Methods:** This hospital-based cross-sectional study included 100 newly diagnosed pulmonary tuberculosis patients, comprising 40 paediatric ( $\leq 14$  years) and 60 adult ( $> 14$  years) cases. All patients underwent chest radiography, and computed tomography of the chest was performed in selected cases. Radiological findings such as lymphadenopathy, consolidation, cavitation, nodular lesions, miliary pattern, pleural effusion, and fibrotic changes were analysed and compared between the two groups using descriptive statistics and the Chi-square test.

**Results:** Lymphadenopathy (65%) and consolidation (55%) were the most common radiological findings in paediatric patients, whereas cavitory lesions (46.7%) and fibrotic changes (36.7%) predominated in adults. Upper lobe involvement was significantly more frequent in adults, while middle and lower lobe involvement was common in children. The difference in radiological patterns between paediatric and adult patients was statistically significant ( $p < 0.05$ ).

**Conclusion:** Pulmonary tuberculosis exhibits distinct age-related radiological patterns, with primary tuberculosis features predominating in children and post-primary disease features in adults. Awareness of these differences aids in early diagnosis and appropriate management, particularly in high-burden tertiary care settings.

**Keywords:** Pulmonary tuberculosis, Radiological spectrum, Chest X-ray, Paediatric tuberculosis, Adult tuberculosis.

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### INTRODUCTION

Tuberculosis (TB) is a chronic infectious disease caused by *Mycobacterium tuberculosis* and continues to be a major cause of morbidity and mortality worldwide, particularly in developing countries. Despite the availability of effective antitubercular therapy, TB remains a significant public health problem due to factors such as delayed diagnosis, incomplete treatment, and socio-economic determinants. Pulmonary tuberculosis (PTB) is the most common form of the disease and accounts for the majority of TB transmission within the community.<sup>1,2</sup>

Radiological imaging plays a crucial role in the diagnosis and management of pulmonary tuberculosis. Chest radiography is often the initial imaging modality employed in suspected cases because it is inexpensive, widely available, and provides rapid information regarding disease presence, extent, and complications.<sup>3</sup> Although microbiological confirmation using sputum smear microscopy, culture, or molecular tests is considered the gold standard, radiological findings frequently guide early diagnosis and initiation of treatment, especially in smear-negative cases and in children.<sup>4</sup>

The radiological appearance of pulmonary tuberculosis varies widely and is influenced by host immunity, age, and the stage of disease. Paediatric pulmonary tuberculosis usually represents primary infection and differs significantly from adult disease in its radiological manifestations. Children commonly exhibit lymphohematogenous spread, resulting in prominent hilar or mediastinal lymphadenopathy, segmental or lobar consolidation, and less frequently, pleural effusion or miliary

nodules.<sup>5,6</sup> Cavitation is relatively uncommon in paediatric patients due to an immature cell-mediated immune response and limited tissue necrosis.

In contrast, adult pulmonary tuberculosis is more often a manifestation of post-primary or reactivation disease. Radiological features in adults typically include upper lobe predominance, patchy or confluent consolidation, cavitary lesions, nodular opacities, fibrosis, and volume loss.<sup>7</sup> Cavitory disease is of particular importance as it reflects high bacillary burden, increased infectivity, and a greater risk of disease transmission.<sup>8</sup>

Computed tomography (CT) of the chest has emerged as an important adjunct to chest radiography in the evaluation of pulmonary tuberculosis. CT is more sensitive in detecting early parenchymal lesions, subtle cavitation, bronchogenic spread, lymphadenopathy, and complications such as bronchiectasis and pleural involvement.<sup>9</sup> In paediatric patients, CT is especially valuable for assessing mediastinal lymph nodes and airway compression, which may not be adequately demonstrated on plain radiographs.<sup>10</sup>

Despite the high prevalence of tuberculosis in endemic regions, comparative studies describing the radiological spectrum of pulmonary tuberculosis in paediatric versus adult populations within the same clinical setting are limited. A clear understanding of age-specific radiological patterns is essential for improving diagnostic accuracy, facilitating early treatment, and reducing disease-related morbidity. The present study was therefore undertaken to analyse and compare the radiological spectrum of pulmonary tuberculosis in paediatric and adult patients presenting to a tertiary care centre.

## **MATERIALS AND METHODS**

### **Study Design**

This was a hospital-based cross-sectional observational study conducted to evaluate the radiological spectrum of pulmonary tuberculosis in paediatric and adult patients.

### **Study Setting**

The study was carried out in the Department of Radiodiagnosis, in collaboration with the Departments of Pulmonary Medicine and Paediatrics, at a tertiary care teaching hospital.

### **Study Period**

The study was conducted over a period of 12 months, from January 2019 to December 2019.

#### **Study Population and Sample Size**

A total of 100 patients diagnosed with pulmonary tuberculosis were included in the study.

- Paediatric group: 40 patients ( $\leq 14$  years)
- Adult group: 60 patients ( $> 14$  years)

The sample size was selected based on feasibility and availability of newly diagnosed pulmonary tuberculosis cases during the study period.

#### **Inclusion Criteria**

- Patients with clinical features suggestive of pulmonary tuberculosis
- Radiologically suspected pulmonary tuberculosis
- Microbiologically confirmed cases (sputum smear positive / CBNAAT positive) or clinically diagnosed cases started on antitubercular treatment
- Newly diagnosed, treatment-naïve patients

#### **Exclusion Criteria**

- Isolated extrapulmonary tuberculosis
- Previously treated or relapse cases of pulmonary tuberculosis
- Patients with lung malignancy or chronic interstitial lung disease
- Poor-quality or incomplete radiological images

#### **Radiological Evaluation**

##### **Chest Radiography**

All patients underwent standard chest radiography (PA view in adults; PA/AP view in paediatric patients). Radiographs were reviewed independently by two experienced radiologists, blinded to clinical details.

##### **Computed Tomography**

CT chest was performed in selected cases with:

- Inconclusive chest X-ray findings
- Suspicion of mediastinal lymphadenopathy

- Suspected complications such as cavitation or bronchiectasis

#### Radiological Parameters Assessed

- Hilar/mediastinal lymphadenopathy
- Pulmonary consolidation
- Cavitory lesions
- Nodular opacities
- Miliary pattern
- Pleural effusion
- Fibrosis and calcification
- Lobar distribution and laterality

#### Statistical Analysis

Data were analysed using SPSS version 20.0.

- Categorical variables: frequency and percentage
- Continuous variables: mean  $\pm$  SD
- Comparison between paediatric and adult groups: Chi-square test
- $p < 0.05$  considered statistically significant

## RESULTS

A total of **100 patients** with pulmonary tuberculosis were evaluated, including **40 paediatric** and **60 adult** patients.

Male predominance was observed in both paediatric and adult groups, with a higher proportion of males in adult patients as shown in Table 1

**Table 1: Demographic Characteristics**

Parameter	Paediatric (n = 40)	Adult (n = 60)
Mean age (years)	8.8 $\pm$ 3.1	42.3 $\pm$ 14.2
Male	22 (55.0%)	40 (66.7%)
Female	18 (45.0%)	20 (33.3%)

Paediatric patients predominantly showed lymphadenopathy and consolidation, whereas adult patients commonly demonstrated cavitory lesions and fibrotic changes. These differences were statistically significant as shown in Table 2

**Table 2: Comparison of Radiological Findings in Paediatric and Adult Patients**

Radiological Finding	Paediatric (n = 40) n (%)	Adult (n = 60) n (%)	p-value
Lymphadenopathy	26 (65.0)	16 (26.7)	<0.001
Consolidation	22 (55.0)	18 (30.0)	0.01
Cavitory lesions	4 (10.0)	28 (46.7)	<0.001
Nodular opacities	10 (25.0)	18 (30.0)	0.57
Miliary pattern	6 (15.0)	4 (6.7)	0.18
Pleural effusion	8 (20.0)	10 (16.7)	0.67
Fibrosis / calcification	3 (7.5)	22 (36.7)	<0.001

Upper lobe involvement was significantly more common in adults, while paediatric patients more frequently showed middle and lower lobe disease as shown in Table 3

**Table 3: Lobar Distribution of Pulmonary Tuberculosis**

Lobar Involvement	Paediatric (n = 40) n (%)	Adult (n = 60) n (%)	p-value
Upper lobes	10 (25.0)	36 (60.0)	<0.001
Middle lobe / Lingula	14 (35.0)	10 (16.7)	0.03
Lower lobes	16 (40.0)	14 (23.3)	0.04
Bilateral involvement	9 (22.5)	20 (33.3)	0.21

CT chest detected additional findings, particularly mediastinal lymphadenopathy in paediatric patients and bronchiectasis and cavitation in adults as shown in Table 4

**Table 4: Additional CT Chest Findings**

CT Finding	Paediatric (n = 16) n (%)	Adult (n = 24) n (%)
Mediastinal lymphadenopathy	12 (75.0)	9 (37.5)
Endobronchial spread	5 (31.3)	11 (45.8)
Early cavitation	2 (12.5)	9 (37.5)
Bronchiectasis	3 (18.8)	12 (50.0)

## DISCUSSION

Pulmonary tuberculosis continues to demonstrate a wide spectrum of radiological manifestations, influenced largely by age-related immune responses and disease pathophysiology. In the present study, distinct differences were observed between paediatric and adult patients with pulmonary tuberculosis, emphasizing the importance of age-specific radiological interpretation.

In this study, a male predominance was observed in both paediatric and adult groups, with a higher proportion of males among adults. Similar gender distribution has been reported in previous studies, which attribute this pattern to increased exposure, occupational risk, smoking, and health-seeking behavior among males, particularly in adult populations.<sup>11,12</sup>

Lymphadenopathy was the most common radiological finding in paediatric patients (65%), significantly higher than in adults. This finding is consistent with earlier studies that describe lymph node involvement as a hallmark of primary tuberculosis in children.<sup>13,14</sup> The immature cell-mediated immunity in children facilitates lymphohematogenous spread of *Mycobacterium tuberculosis*, leading to prominent hilar and mediastinal lymphadenopathy. In contrast, adults typically mount a stronger delayed hypersensitivity response, resulting in localized parenchymal disease rather than nodal involvement.

Pulmonary consolidation was also more frequently observed in paediatric patients than adults. Segmental or lobar consolidation in children often represents primary infection and may mimic bacterial pneumonia, leading to diagnostic challenges.<sup>15</sup> This underscores the importance of careful radiological assessment and clinical correlation in paediatric patients presenting with non-resolving pneumonia.

Cavitary lesions were significantly more common in adult patients (46.7%) compared to paediatric patients (10%). Cavitation is a characteristic feature of post-primary or reactivation tuberculosis and reflects extensive lung parenchymal destruction due to a robust immune response.<sup>16</sup> Cavitory disease is associated with high bacillary load and increased infectivity, making early detection crucial for disease control. The low prevalence of cavitation in children observed in this study is in agreement with previous literature.<sup>17</sup>

Upper lobe predominance was significantly higher in adult patients, whereas paediatric patients more frequently showed middle and lower lobe involvement. These findings align with classical descriptions of pulmonary tuberculosis, wherein adult disease favors oxygen-rich upper lobes, while paediatric disease shows less lobar predilection.<sup>18,19</sup> Bilateral involvement, although more common in adults, did not show a statistically significant difference, suggesting that disease dissemination may occur across age groups depending on host factors and disease duration.

Miliary tuberculosis was observed more frequently in paediatric patients than adults, though the difference was not statistically significant. This finding is clinically important, as miliary TB reflects hematogenous dissemination and is associated with severe disease and higher morbidity in children.<sup>20</sup> Early radiological recognition of miliary patterns can be lifesaving in paediatric patients.

Computed tomography of the chest provided additional diagnostic information in selected cases. CT detected mediastinal lymphadenopathy more frequently in paediatric patients and early cavitation and bronchiectasis more commonly in adults. Previous studies have demonstrated the superior sensitivity of CT in detecting occult lymph nodes, endobronchial spread, and early parenchymal changes not visible on chest radiographs.<sup>21,22</sup> The findings of the present study further support the role of CT as an adjunct imaging modality, particularly in complex or equivocal cases.

Overall, the findings of this study reinforce the concept that pulmonary tuberculosis manifests differently in paediatric and adult populations. Recognizing these age-specific radiological patterns is essential for early diagnosis, appropriate treatment initiation, and prevention of complications, especially in high TB-burden settings.

## CONCLUSION

Pulmonary tuberculosis shows distinct radiological patterns in paediatric and adult patients. Children commonly present with features of primary tuberculosis such as lymphadenopathy and consolidation, whereas adults predominantly exhibit cavitary and fibrotic lesions of post-primary disease. Upper lobe involvement was more frequent in adults, while middle and lower lobe involvement was common in children. Computed tomography provided additional diagnostic information in selected cases. Recognition of these age-specific radiological features facilitates early diagnosis and appropriate management of pulmonary tuberculosis.

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