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# ASSOCIATION BETWEEN CHEST RADIOGRAPH FINDINGS AND MOLECULAR TEST IN PAEDIATRIC TUBERCULOSIS

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**ABSTRACT**

Tuberculosis (TB) remains a major global health concern, with children representing a substantial proportion of cases. Diagnosis in paediatric populations is challenging due to non-specific clinical features and limited bacteriological confirmation, making chest radiography and molecular rapid tests essential. This study aimed to evaluate the association between chest radiographic abnormalities and molecular rapid test results in paediatric pulmonary TB patients. A retrospective cohort study was conducted at Haji Adam Malik General Hospital from January to May 2025, involving 60 children diagnosed with pulmonary TB. Data were collected through consecutive sampling, comprising demographic characteristics, chest radiographic findings, and molecular rapid test (GeneXpert). Statistical analysis was performed using the chi-square test to evaluate diagnostic parameters. Results: Among 60 patients (46.7% male; mean age 10 years), 48.3% showed abnormal chest radiographs, predominantly infiltrates (60%) and pleural effusion (23.3%). GeneXpert results were evenly distributed, with 30 positive and 30 negative cases. A significant association was found between radiographic abnormalities and molecular test results ($p < 0.001$). Diagnostic parameters for radiographs included sensitivity 0%, specificity 3.3%, and accuracy PPV 0% and NPV 3,2%. Chest radiography is useful for initial paediatric TB screening but less accurate than molecular tests.

Keywords: chest radiograph; diagnostic accuracy; molecular rapid test; paediatric tuberculosis

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## INTRODUCTION

Tuberculosis (TB) is a communicable disease caused by infection with Mycobacterium tuberculosis and remains a major global health burden. The WHO reported 10.6 million TB cases in 2021, including 1.2 million in children, with mortality remaining significant. The global targets outlined in the SDGs (2016–2035) and the WHO End TB Strategy aim to reduce incidence by 80% and mortality by 90% by 2030. In Indonesia, the national target is TB elimination by 2035 and a TB-free country by 2050 (Kementrian Kesehatan Republik Indonesia, 2023).

Indonesia ranked second globally for the highest TB burden in 2022. Childhood TB accounted for 110,881 cases (15.3% of all cases), including 143 cases of extrapulmonary TB, with treatment coverage varying across provinces. Preventive TB therapy (TPT) coverage remains low, reaching only 1.3% of the national target (Pakasi et al., 2023). Childhood TB diagnosis is based on clinical, radiological, and bacteriological findings. Chest radiography plays an important role in assessing severity and treatment response, although its specificity is limited. WHO reports indicate high

sensitivity, yet radiographic interpretation must be combined with clinical evaluation and molecular testing (UNICEF, 2022; Mahomed et al., 2023).

Molecular rapid diagnostic tests such as GeneXpert MTB/RIF provide simultaneous detection of MTB DNA and drug resistance with high accuracy. The WHO recommends GeneXpert and its variants, including Xpert MTB/RIF Ultra and Xpert MTB/XDR, which have demonstrated greater sensitivity than conventional microscopy. In Indonesia, GeneXpert has been adopted as the primary diagnostic tool[7]. In North Sumatra, 98 childhood TB cases (aged 0–14 years) were reported, with the highest distribution in children aged <1 year (2%) and 1–4 years (4%). In Medan City, the number of childhood TB cases reached 377 in 2018, with fluctuating notification trends for both smear-positive and overall TB cases between 2014 and 2018 (Kementrian Kesehatan Republik Indonesia, 2023). These findings emphasise the importance of reliable diagnostic facilities to accelerate detection and treatment of TB in children. This study therefore aims to examine the association between chest radiograph severity and molecular rapid test results in paediatric pulmonary tuberculosis patients at Haji Adam Malik General Hospital, stratified by age.

## METHOD

This study was an analytical retrospective cohort design and was conducted at the Paediatric Respirology Outpatient Clinic of Haji Adam Malik General Hospital, Medan, between January and May 2025. Sampling was performed using a consecutive technique, whereby all eligible patients meeting the inclusion criteria were enrolled until the required sample size was achieved. The inclusion criteria were: (1) children diagnosed with pulmonary TB between January and May 2025; (2) aged <18 years; and (3) availability of molecular rapid test results. The exclusion criterion was patients with drug-resistant TB (MDR-TB). Ethical approval was obtained from the Ethics Committee of the Faculty of Medicine, Universitas Sumatera Utara/Haji Adam Malik General Hospital.

Data were collected from digital medical records of paediatric patients diagnosed with pulmonary TB. Variables included demographic characteristics, chest radiograph findings, molecular rapid test results, and HIV status. Chest radiographs were categorised into two groups: suggestive (defined by hilar or paratracheal lymphadenopathy with/without infiltrates, segmental/lobar consolidation, pleural effusion, miliary pattern, atelectasis, cavitation, calcification with infiltrates, or lymphadenopathy) and non-suggestive (radiographic findings other than those suggestive of TB). The molecular rapid test was performed on sputum or other relevant specimens using the GeneXpert assay, with results recorded as either positive or negative. GeneXpert was used as the gold standard, as recommended by the WHO, given its reliability and diagnostic accuracy. Data analysis was conducted using the chi-square test on 2×2 contingency tables to calculate diagnostic parameters, including sensitivity, specificity, accuracy, positive predictive value, and negative predictive value.

## RESULT

The majority of paediatric pulmonary tuberculosis cases in this study were classified as primary pulmonary TB, with a smaller proportion presenting with HIV co-infection or relapse. Most patients exhibited normal chest radiographs; however, pulmonary infiltrates were the most common abnormal finding among those with radiological changes. Molecular rapid testing showed an equal distribution of positive and negative results. Chi-square analysis revealed a significant association between chest radiograph findings and molecular rapid results ($p < 0.001$). All patients with abnormal radiographs tested negative, while nearly all with normal radiographs tested positive. Chest radiography showed zero sensitivity, 3.3% specificity, zero positive predictive value, and a 3.2% negative predictive value. These results suggest that chest radiography alone is unreliable for diagnosing paediatric pulmonary TB, highlighting the essential role of molecular testing for accurate diagnosis.

Table 1.
Demographic Characteristics of Patient (n = 60)

| Demographic Characteristics | f (%) |
|---|---|
| Sex, f (%) | |
| Male | 28 (46.7) |
| Female | 32 (53.3) |
| Age, *years* | 9.96 ± 6.35 |
| *Median* | 10.25 (0.42 – 17.92) |
| Weight, *kg* | 28.67 ± 23.97 |
| *Median* | 24.1 (4.6 – 147) |
| Height, *cm* | 123.46 ± 34.27 |
| *Median* | 127.5 (62 – 176) |
| Diagnosis, f (%) | |
| Pulmonary TB | 51 (85) |
| Pulmonary TB and HIV | 6 (10) |
| Relapse pulmonary TB | 3 (5) |

Table 2.
Chest X-ray Findings, Abnormalities, and Distribution of Molecular Rapid Test Results of Patient (n = 60)

| Characteristics | f (%) |
|---|---|
| Chest X-ray Findings | |
| Atelectasis | 5 (8.3) |
| Lymphadenopathy | 3 (5) |
| Pleural effusion | 14 (23.3) |
| Miliary | 2 (3.3) |
| Infiltrate | 36 (60) |
| Chest X-ray Abnormalities | |
| Positive | 29 (48.3) |
| Negative | 31 (51.7) |
| Specimen Types of Molecular Rapid Test | |
| Sputum | 38 (63.3) |
| Gastric lavage | 22 (36.7) |
| Results of Molecular Rapid Test | |
| Positive | 30 (50) |
| Negative | 30 (50) |

Table 3.
Diagnostic Accuracy of Chest X-ray Abnormalities Compared with Molecular Rapid Test Results in Children with Pulmonary Tuberculosis

| Chest X-ray Abnormalities | Molecular Rapid Test | | p | Sensitivity | Specificity | PPV | NPV |
|---|---|---|---|---|---|---|---|
| | Positive | Negative | | | | | |
| Positive | 0 (0) | 29 (100) | <0.001* | 0% | 3.3% | 0% | 3.2% |
| Negative | 30 (96.8) | 1 (3.2) | | | | | |

PPV= Positive Predictive Value
NPV= Negative Predictive Value
*Chi square analysis

## DISCUSSION

This study involved 60 children with pulmonary tuberculosis, consisting of 32 females (53.3%) and 28 males (46.7%). The distribution was relatively balanced, although slightly more prevalent among females. This finding contrasts with several studies reporting male predominance, such as those

conducted in China (54.8%) (Wang et al., 2024), Turkey (55%), and Brazil (56%) (Shah et al., 2020; Sousa et al., 2019). Conversely, the present result is consistent with Aygun et al. (2019) in Istanbul (57.7% females) and Vukugah et al. (2022) in Cameroon (50.3% females). Such variations may be attributed to sociocultural determinants, healthcare access, and reporting systems across different regions (Vukugah et al., 2022; Aygun et al., 2019).

The mean age of patients was 10 ± 6.24 years (range 0.42–17.92 years), indicating that paediatric TB can occur from infancy through late adolescence. This mean age was higher than that reported by Shah et al. (2020) (5.3 ± 3.5 years), but comparable to Aygun et al. (2019) (9.85 ± 5.03 years) and Wang et al. (2024) (9.11 ± 4.39 years). Dhaked et al. (2019) also noted that most children (88%) were older than 5 years. Similarly, Awaluddin et al. (2020) in Malaysia observed the highest proportion in the 10–14 years group (43.5%), followed by 0–4 years (37%) and 5–9 years (19.5%). Wang et al. (2024) likewise reported 56.5% of cases within the 10–14 years range, highlighting early adolescence as a vulnerable period for paediatric TB.

The mean body weight was 28.67 ± 23.97 kg and mean height 123.46 ± 34.27 cm. Although nutritional status was not formally categorised, these findings underscore the importance of nutritional evaluation. Previous studies have shown high rates of malnutrition among children with TB: Al Araf and Airlangga (2019) reported 84.8% with severe malnutrition, de Geus et al. (2025) in South Africa identified 22% underweight and 30% stunting, while Aygun et al. (2019) found nearly half below the third percentile. These results emphasise the strong association between poor nutritional status and susceptibility to TB as well as adverse prognosis.

Regarding diagnosis, 85% had pulmonary TB, 10% pulmonary TB with HIV, and 5% relapse cases. The proportion of TB–HIV was lower than that observed in Zimbabwe (58.3%), but in line with Aygun et al. (2019), who reported no HIV-positive children. Differences are likely due to regional HIV prevalence and screening practices. Radiological assessment revealed a wide spectrum of abnormalities: 29 patients (48.3%) presented with abnormal chest radiographs, whereas 31 patients (51.7%) exhibited no radiographic abnormalities. The most prevalent abnormality was pulmonary infiltrates, observed in 36 patients (60%), followed by pleural effusion in 14 patients (23.3%), atelectasis in 5 patients (8.3%), lymphadenopathy in 3 patients (5%), and a miliary pattern in 2 patients (3.3%). Comparable findings have been reported in previous studies, including mediastinal lymphadenopathy and pneumonic infiltrates, consolidation and pleural effusion (Shah et al., 2020), and hilar lymphadenopathy with lobar consolidation (Aygun et al., 2019). However, some studies demonstrated normal chest radiographs in up to one-third of children (Shah et al., 2020; Laghari et al., 2019). By contrast, others reported over 90% with abnormal findings (Sharma et al., 2020; Awang et al., 2019). These discrepancies highlight that chest radiography in paediatric TB has variable sensitivity, influenced by disease stage, radiological expertise, and the paucibacillary nature of paediatric disease.

In this study, 45 children (75%) had abnormal chest radiographs, while 15 (25%) showed no abnormalities. Most underwent Rapid Molecular Testing (Xpert MTB/RIF, GeneXpert) using sputum (63.3%), while 36.7% used gastric lavage. Of these, 30 (50%) tested positive and 30 (50%) negative, reflecting moderate sensitivity. This positivity rate was higher than several prior studies (Yadav et al., 2020; Mutemba et al., 2023; Garba et al., 2023), but lower than Velayutham et al. (2024) and Atherton et al. (2019), who reported sensitivities of 62–68% depending on specimen type. Statistical analysis revealed a significant association between radiological abnormalities and molecular test results ($p < 0.001$). Nonetheless, chest radiography demonstrated limited diagnostic performance, with Diagnostic testing indicated that chest radiography had zero sensitivity, specificity of 3.3%, zero positive predictive value, and negative predictive value of 3.2%. These findings indicate that while chest radiographs remain an essential initial diagnostic tool, they lack sufficient accuracy as a standalone test. Similar conclusions have been drawn in Indonesia, where

low but significant concordance between radiography and GeneXpert has been reported (Anggraini et al., 2024; Sulistiana, 2023). Overall, the results emphasise the need for a multimodal approach integrating clinical evaluation, radiological assessment, molecular testing, and nutritional status monitoring to achieve accurate diagnosis and effective management of paediatric TB.

## CONCLUSION

This study demonstrated a significant association between radiological findings and Rapid Molecular Testing, but with low chest radiograph accuracy, reinforcing the need for a comprehensive diagnostic approach. Future studies should include larger samples, prospective and multi-centre designs to enhance generalisability. Evaluation of other diagnostic modalities (e.g. culture) and optimisation of molecular specimen collection are warranted, alongside consideration of clinical factors such as nutritional status, immune function, HIV, and close-contact history, to achieve a more accurate and risk-based diagnostic strategy.

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