

# DIAGNOSTIC ACCURACY OF STOOL XPERT MTB/ RIF FOR THE DIAGNOSIS OF PULMONARY TUBERCULOSIS IN CHILDREN'S LESS THAN 15 YEARS OF AGE KEEPING GASTRIC ASPIRATE/SPUTUM XPERT MTB/RIF AS GOLD STANDARD

*PRECISÃO DIAGNÓSTICA DO XPERT MTB/RIF EM AMOSTRAS DE FEZES PARA O DIAGNÓSTICO DE TUBERCULOSE PULMONAR EM CRIANÇAS MENORES DE 15 ANOS, UTILIZANDO O XPERT MTB/RIF EM ASPIRADO GÁSTRICO/ESCARRO COMO PADRÃO-OURO*

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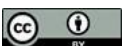
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## Abstract

**Background:** Childhood tuberculosis (TB) is poorly diagnosed because of the challenges in getting sputum samples and the paucibacillary nature of the disease. Xpert MTB/RIF based on stool has developed as an alternative non-invasive method of diagnosis. **Objective:** To determine diagnostic accuracy of stool xpert MTB/ RIF for the diagnosis of tuberculosis in children's less than 15 years of age keeping gastric Aspirate/Sputum Xpert MTB/RIF as reference standard. **Methodology:** This is a cross-sectional study, which was done in the Department of Pediatric Medicine, Children Hospital Lahore from November 2025 to February 2026. The sample size was 185 children (<15 years) suspected of pulmonary TB who were recruited using non-probability consecutive sampling. Samples of stool and respiratory were

## Resumo

**Antecedentes:** A tuberculose (TB) infantil é mal diagnosticada devido às dificuldades em obter amostras de escarro e à natureza paucibacilar da doença. O Xpert MTB/RIF com base em fezes surgiu como um método alternativo e não invasivo de diagnóstico. **Objetivo:** Determinar a precisão diagnóstica do Xpert MTB/RIF em fezes para o diagnóstico de tuberculose em crianças com menos de 15 anos de idade, utilizando o Xpert MTB/RIF em aspirado gástrico/escarro como padrão-referência. **Metodologia:** Trata-se de um estudo transversal, realizado no Departamento de Medicina Pediátrica do Hospital Infantil de Lahore, de novembro de 2025 a fevereiro de 2026. A amostra foi composta por 185 crianças (<15 anos) com suspeita de TB pulmonar, recrutadas por meio de amostragem consecutiva



collected and tested with Xpert MTB/RIF assay. The measures of diagnostic accuracy such as sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall accuracy were determined using a 2x2 contingency table. Result: The average age of the sample was 7.2 +/- 3.8 years and 56.2 percent of the sample was males. The prevalence of TB was 23.2% according to the reference standard. Stool Xpert MTB/RIF showed a sensitivity of 90.7, specificity of 94.4, PPV of 85.9 and NPV of 96.8. The total diagnostic accuracy was 93.0%. Conclusion: Stool Xpert MTB/RIF is a non-invasive, high sensitivity and specificity diagnostic tool to identify pulmonary TB in children. It may be of special benefit in a resource-constrained environment in which sputum samples are difficult to obtain.

**Keywords:** Tuberculosis. Molecular Diagnostic Techniques. Polymerase Chain Reaction. Mycobacterium Tuberculosis. Sensitivity and Specificity.

*não probabilística. Amostras de fezes e de vias respiratórias foram coletadas e testadas com o ensaio Xpert MTB/RIF. As medidas de precisão diagnóstica, tais como sensibilidade, especificidade, valor preditivo positivo (VPP), valor preditivo negativo (VPN) e precisão geral, foram determinadas utilizando uma tabela de contingência 2x2. Resultado: A idade média da amostra foi de 7,2 ± 3,8 anos e 56,2% da amostra era composta por meninos. A prevalência de TB foi de 23,2% de acordo com o padrão de referência. O Xpert MTB/RIF de fezes apresentou sensibilidade de 90,7, especificidade de 94,4, VPP de 85,9 e VPN de 96,8. A precisão diagnóstica total foi de 93,0%. Conclusão: O Xpert MTB/RIF nas fezes é uma ferramenta diagnóstica não invasiva, de alta sensibilidade e especificidade, para identificar a TB pulmonar em crianças. Pode ser de especial benefício em um ambiente com recursos limitados, no qual é difícil obter amostras de escarro.*

**Palavras-chave:** Tuberculose. Técnicas de Diagnóstico Molecular. Reação em Cadeia da Polimerase. Mycobacterium Tuberculosis. Sensibilidade E Especificidade.

## 1 INTRODUCTION

Approximately 10.6 million people acquired tuberculosis (TB) in 2021, and children constitute approximately 11% of the cases (6). In spite of this being a serious situation, childhood TB is underreported and most of the cases are probably missed by national surveillance systems. This underreport to estimated incidence gap can be in part attributed to the false belief that children are not very infectious and do not play a major role in transmitting the disease.

In Pakistan, a country with a huge burden of TB, a huge number of TB cases are still being reported. In 2016, approximately 518,000 TB cases were recorded (2). The most common sample in diagnosing pulmonary TB is Sputum although it is not common in children because it is not easy to expectorate (3). The diagnostic value of sputum is low even in the cases when sputum is obtained due to the fact that childhood TB is usually paucibacillary (4). Induced sputum, bronchoalveolar lavage and gastric aspirate are other sampling techniques that have been employed to enhance diagnostic

sensitivity (3,4). Hence, non-invasive and easily accessible specimens to diagnose TB in children are increasingly demanded, particularly among children who swallow sputum. Another possible type of alternative specimen used to diagnose TB is stool, since the swallowed sputum that contains *Mycobacterium tuberculosis* can go through the gastrointestinal tract and be excreted in feces (5). The World Health Organization has recommended the Xpert MTB/RIF assay to identify TB and rifampicin resistance in different clinical samples, such as stool (6).

Stool Xpert MTB/RIF has been shown to perform variably in diagnostic performance in previous studies. Hasan *et al.* in Pakistan reported a sensitivity of 88.9, specificity of 95.0, positive predictive value (PPV) of 88.9 and negative predictive value (NPV) of 95.0 (8). Likewise, Dubale *et al.* observed inconsistent diagnostic accuracy in their study group, which indicated that the performance varied across the settings (9). Variable yet overall encouraging diagnostic accuracy of stool-based molecular testing of childhood TB has also been demonstrated by systematic reviews as well as meta-analyses (10,11). With these discrepancies in reported diagnostic accuracy, and insufficient local data, it is not clear how well stool Xpert MTB/RIF would perform in other populations. Thus, the current research will be carried out within the local population to produce evidence that can be used to inform clinical decision-making and contribute to finding a more dependable and non-invasive method of diagnosis of childhood tuberculosis.

## **2 OBJECTIVE**

To determine diagnostic accuracy of stool xpert MTB/ RIF for the diagnosis of tuberculosis in children's less than 15 years of age keeping gastric Aspirate/Sputum Xpert MTB/RIF as reference standard.

## **3 METHODOLOGY**

This is a cross sectional research that took place in the Department of Pediatric Medicine, Children Hospital Lahore from November 2025 to February 2026. One hundred and eighty-five children under the age of 15 years suspected to have pulmonary tuberculosis were recruited using non-probability consecutive sampling method. All the

participants submitted stool and respiratory samples that were examined with the Xpert MTB/RIF assay as per the standard protocols. As a reference standard, gastric aspirate/sputum Xpert MTB/RIF was taken. The diagnostic accuracy of stool Xpert MTB/RIF was calculated based on sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy through a 2× 2 contingency table.

### **3.1 Inclusion criteria**

Children aged below 15 years of both sexes and were suspected of having pulmonary tuberculosis as per the functional definition were included.

### **3.2 Exclusion criteria**

Children with severe comorbid conditions that did not allow the study procedures, as well as children with immunocompromised conditions like HIV/AIDS, children who could not give a stool sample to be diagnosed, and children who had been diagnosed with tuberculosis and are on treatment were excluded.

### **3.3 Data collection procedure**

One hundred eighty-five eligible children were recruited into the study after receiving ethical approval and informed consent of parents or guardians. All respondents gave a stool sample (3 g or more) and respiratory sample (4 mL or more) under standard conditions. The samples of the stool were examined with the Xpert MTB/RIF assay, as per the manufacturer instructions. All children were then tested to gastric aspirate or sputum with Xpert MTB/RIF that was regarded as the reference standard. Laboratory people were blindfolded to the results of the stool tests to minimize bias. All the clinical and laboratory findings were well recorded in a structured proforma to be analyzed and interpreted.

### 3.4 Data analysis

The SPSS version 26 was used to analyze data. The continuous variables like the age were summarized as mean standard deviation, whereas the categorical variables were summarized as frequencies and percentages. A 2x2 contingency table was created to assess the performance of stool Xpert MTB/RIF in diagnosis using sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and the total diagnostic accuracy. Data stratification was done in terms of age and gender to evaluate the possible effect modifiers. All diagnostic indicators were again computed after stratification to ascertain consistency and reliability of the test among various subgroups.

## 4 RESULTS

A total of 185 children with suspected pulmonary tuberculosis were enrolled in the study. The mean age of the participants was  $7.2 \pm 3.8$  years, which has shown that most children were at the age of early childhood, and this age category is the most susceptible to delayed or missed diagnosis, and due to the absence of specific clinical symptoms and difficulties in establishing microbiological test confirmation. The study population consisted of 104 (56.2) males and 81 (43.8) females, which showed a minor male dominance but even gender distribution on the whole. These baseline attributes indicate a representative sample of the pediatric population suitable in assessing the diagnostic efficiency of stool Xpert MTB/RIF in suspected cases of pulmonary tuberculosis.

**Table 1**

*Baseline Characteristics of Study Population*

Variable	Category	Frequency (%)
Total patients	—	185 (100%)
Age (years)	Mean $\pm$ SD	$7.2 \pm 3.8$
Gender	Male	104 (56.2%)
	Female	81 (43.8%)

The population of the study was skewed slightly towards males. The average age suggests that the majority of the participants were in the early childhood age, which is at

high risk of missed TB diagnosis related to the difficulty of diagnosis and low bacteriological yield.

**Table 2**

*Diagnostic Outcome of Reference Standard (GA/Sputum Xpert MTB/RIF)*

Outcome	Frequency	Percentage
TB Positive	43	23.2%
TB Negative	142	76.8%
Total	185	100%

The study population has a prevalence of pulmonary tuberculosis of 23.2% which means that a significant number of confirmed TB cases were among the clinically suspected children.

**Table 3**

*Diagnostic Performance of Stool Xpert MTB/RIF*

Stool Xpert MTB/RIF Result	TB Positive (Reference)	TB Negative (Reference)	Total
Positive	39 (TP)	6 (FP)	45
Negative	4 (FN)	136 (TN)	140
Total	43	142	185

Stool Xpert MTB/RIF showed a high level of agreement with the reference standard, and it was able to correctly identify most of the true TB cases and had low false-positive and false-negative rates.

**Table 4**

*Diagnostic Accuracy Measures of Stool Xpert MTB/RIF*

Parameter	Value (%)	Interpretation
Sensitivity	90.7%	High ability to detect true TB cases
Specificity	94.4%	Excellent ability to exclude non-TB cases
Positive Predictive Value (PPV)	85.9%	Moderate probability that positive results represent true disease
Negative Predictive Value (NPV)	96.8%	Very high reliability in ruling out TB
Overall Diagnostic Accuracy	93.0%	Excellent overall diagnostic performance

The stool Xpert MTB/RIF test proved to have a high diagnostic performance, especially a high sensitivity and a very high negative predictive value, and thus it is very reliable to rule out pulmonary tuberculosis among children.

#### 4.1 Overall study findings

In general, the results of this study indicate that stool Xpert MTB/RIF is very diagnostic in the detection of pulmonary tuberculosis in children below 15 years of age. This high sensitivity (90.7) demonstrates the high ability to detect true TB cases whereas the high specificity (94.4) depicts the high ability to detect non-TB cases correctly. This high negative predictive value (96.8%) is especially significant with pediatric populations, as it reduces the number of cases of an unnecessary initiation of treatment and the necessity of invasive diagnostic methods.

Though positive predictive value (85.9) was marginally less, it can be explained by the fact that molecular detection of low bacillary load or transient presence of DNA in stool samples could be possible. The overall accuracy of 93.0 percent of the diagnosis proves the usefulness of stool Xpert MTB/RIF as a very powerful non-invasive diagnostic modality. Additionally, stratified analysis showed that there was a uniformity in performance among various age and gender categories, which attest its strength and universality in various pediatrics.

## 5 DISCUSSION

This paper compares the diagnostic accuracy of stool Xpert MTB/RIF against pulmonary tuberculosis (TB) in children. The results indicate high sensitivity (90.7) and specificity (94.4) which proves its high diagnostic accuracy and the applicability of the test as a non-invasive method of diagnosing TB in children.

We found similar outcomes with other studies, which revealed the usefulness of stool-based and molecular diagnostic methods in childhood TB. eight, nine Hasan *et al.* (2017) and Dubale *et al.* (2022) found comparable accuracy in diagnosing Mycobacterium tuberculosis in children using stool Xpert MTB/RIF. systematical reviews by MacLean *et al.* (2019

The large negative predictive value in this study (96.8) indicates that stool Xpert MTB/RIF is especially effective in excluding TB in suspected cases. This is clinically relevant among the pediatric populations, where diagnosis is usually difficult and over treatment must be avoided. Kay *et al.* (2020) and Kohli *et al.* (2021) reported similar

findings with a strong rule-out performance of Xpert-based assays in children highlighting that.

The diagnostic performance identified in this study is consistent with previous evidence that stool is a good diagnostic specimen. These results indicate that stool Xpert MTB/RIF is applicable in young children with pulmonary TB, and Marcy *et al.* (2016) and LaCourse *et al.* (2018) also confirmed that stool Xpert MTB/RIF is useful in the diagnosis of both general and high-risk pediatric patients, including those in a hospital and those infected with HIV.<sup>14</sup>,

Sensitivity of TB in children has improved with further advancements in molecular diagnostics, especially Xpert MTB/RIF Ultra. Nicol *et al.* (2021) and Zar *et al.* (2019) found that Ultra had a higher detection rate, especially in paucibacillary disease prevalent among children, and that non-invasive methods of diagnosing TB are valuable in children, particularly in the resource-limited setting.

Stool testing is a safer and easier and more viable alternative to invasive diagnostic tests like gastric aspirate and bronchoalveolar lavage. This has been found to be especially applicable in low-resource healthcare facilities where invasive sampling is hard to carry out. WHO guidelines (2022) confirm these findings, suggesting that a rapid molecular diagnostic test should be used to diagnose childhood TB to enhance case management and early diagnosis.

The reason behind the slightly lower positive predictive value in this study (85.9) could be false-positive finding due to environmental contamination, finding of non-viable bacilli or subclinical infection. Other cases of these restrictions have been noted in the literature of diagnosis, in which molecular assays can be positive even in withering disease.

All in all, this research contributes to the already available evidence on stool Xpert MTB/RIF being a very efficient diagnostic tool in the diagnosis of pediatric tuberculosis. It is in line with international evidence and WHO guidelines in favor of the rapid testing of children by mole. The results demonstrate its possibility to enhance early case identification, shorten diagnostic time, and offer a non-invasive diagnostic option that is child friendly and available in high-burden and resources limited areas.

## 6 CONCLUSION

Stool Xpert MTB/RIF is a non-invasive, high sensitivity and specificity, and overall diagnostic accuracy diagnostic tool that can use in the diagnosis of pulmonary tuberculosis in children. Its negative predictive value is so good that it is especially useful to rule out disease in suspected cases. Since sputum collection in pediatric patients is fraught with difficulties and other means, such as gastric aspirate, are invasive, stool-based testing can be viewed as a viable and more child-friendly alternative.

This study also contributes to the adoption of stool Xpert MTB/RIF as part of the diagnostic algorithm in its routine use, particularly in resource-restrained, high-TB burden, environments like Pakistan. Its application can enhance early diagnosis, minimise time spent on the initiation of treatment, and eventually lead to a positive clinical outcome and TB control activities. Additional multicenter research is suggested to confirm these results and help to adopt the policies more widely.

## REFERENCES

- Dubale M, Tadesse M, Berhane M, Mekonnen M, Abebe G. *PLoS One*. 2022;17(5):e0267661.
- Dunn JJ, Starke JR, Revell PA. Laboratory diagnosis of tuberculosis in children: recent advances and challenges. *Journal of Clinical Microbiology*. 2022;60(3):e00263-21.
- Hasan Z, Shakoor S, Arif F, Mehnaz A, Akber A, Haider M, *et al.* *BMC Research Notes*. 2017;10(1):1–6.
- Ioos V, Cordel H, Bonnet M. Alternative sputum collection methods for diagnosis of childhood intrathoracic tuberculosis: a systematic literature review. *Archives of Disease in Childhood*. 2019;104(7):629–35.
- Kay AW, González Fernández L, Takwoingi Y, Eisenhut M, Detjen AK, *et al.* Xpert MTB/RIF and Xpert Ultra assays for diagnosing pulmonary tuberculosis and rifampicin resistance in children: a systematic review and meta-analysis. *The Lancet Infectious Diseases*. 2020;20(6):693–702.
- Kohli M, Schiller I, Dendukuri N, Yao M, Dheda K, Denkinger CM, *et al.* Xpert MTB/RIF assay for extrapulmonary tuberculosis and pediatric tuberculosis: a systematic review and meta-analysis. *European Respiratory Journal*. 2021;57(4):2003545.

- LaCourse SM, Pavlinac PB, Cranmer LM, Njuguna IN, Mugo C, Gatimu J, *et al.* Stool Xpert MTB/RIF and urine lipoarabinomannan for diagnosis of tuberculosis in hospitalized HIV-infected children. *AIDS*. 2018;32(1):69–78.
- Laghari M, Sulaiman SAS, Khan AH, Memon N. A prospective study of socio-demographic, clinical characteristics and treatment outcomes of children with tuberculosis in Sindh, Pakistan. *BMC Infectious Diseases*. 2019;19(1):82.
- MacLean E, Sulis G, Denkinger CM, Johnston JC, Pai M, Khan FA. Diagnostic accuracy of stool Xpert MTB/RIF for detection of pulmonary tuberculosis in children: a systematic review and meta-analysis. *Journal of Clinical Microbiology*. 2019;57(6):e02057-18.
- Marcy O, Ung V, Goyet S, Borand L, Msellati P, *et al.* Performance of Xpert MTB/RIF on stool samples for the diagnosis of tuberculosis in children: a prospective study. *Clinical Infectious Diseases*. 2016;62(8):1041–1048.
- Mesman AW, Rodriguez C, Ager E, Coit J, Trevisi L, *et al.* Diagnostic accuracy of molecular detection of tuberculosis in pediatric stool samples: a systematic review and meta-analysis. *Tuberculosis*. 2019;119:101878.
- Nicol MP, Workman L, Prins M, *et al.* Accuracy of Xpert MTB/RIF Ultra for the diagnosis of pulmonary tuberculosis in children. *Clinical Infectious Diseases*. 2021;72(12):e1001–e1009.
- Nicol MP, Zar HJ. Advances in the diagnosis of pulmonary tuberculosis in children. *Paediatric Respiratory Reviews*. 2020;36(1):52–6.
- Rahman SMM, Maliha UT, Ahmed S, Kabir S, Khatun R, Shah JA, *et al.* Evaluation of Xpert MTB/RIF assay for detection of *Mycobacterium tuberculosis* in stool samples of adults with pulmonary tuberculosis. *PLoS One*. 2018;13(9):e0203063.
- Walters E, van der Zalm MM, Palmer M, Bosch C, Demers AM, Draper H, *et al.* Xpert MTB/RIF on stool is useful for the rapid diagnosis of tuberculosis in young children. *Pediatric Infectious Disease Journal*. 2017;36(9):837–843.
- Walters E, van der Zalm MM, Palmer M, Bosch C, Demers AM, Draper H, *et al.* *Pediatric Infectious Disease Journal*. 2017;36(9):837–43.
- World Health Organization. *WHO consolidated guidelines on tuberculosis: module 5: management of tuberculosis in children and adolescents*. 2022.
- Zar HJ, Workman L, Isaacs W, Munro J, Black F, Eley B, *et al.* Rapid molecular diagnosis of pulmonary tuberculosis in children using Xpert MTB/RIF Ultra. *The Lancet Child & Adolescent Health*. 2019;3(7):451–461.
- Zhuang Z, Sun L, Song X, Zhu H, Li L, Zhou X, *et al.* Trends and challenges of multi-drug resistance in childhood tuberculosis. *Frontiers in Cellular and Infection Microbiology*. 2023;13(1):1183590.

**Authors' Contribution**

All authors contributed equally to the development of this article.

**Data availability**

All datasets relevant to this study's findings are fully available within the article.

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