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ORIGINAL ARTICLE

The impact of implementing the Molecular Rapid Test for Tuberculosis in the diagnosis of pulmonary tuberculosis in pediatric patients aged 0 to 14 years in the state of Minas Gerais

O impacto da implementação do Teste Rápido Molecular para Tuberculose no diagnóstico de Tuberculose pulmonar de pacientes pediátricos de 0 a 14 anos no estado de Minas Gerais

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ABSTRACT

Introduction: Tuberculosis (TB), caused by *Mycobacterium tuberculosis*, remains a global public health challenge. Brazil, listed among the 30 countries with the highest TB burden, reports high morbidity and mortality, especially in children under 15 years of age. Early diagnosis in pediatrics is hampered by nonspecific symptoms and the low sensitivity of laboratory tests. Since 2015, the Rapid Molecular Test for Tuberculosis (MRT-TB) has been implemented in Brazil, with significant advances in diagnosis**. Objective:** To evaluate the effectiveness of MRT-TB in the diagnosis of pediatric pulmonary TB in Minas Gerais and its impact on disease notification between 2007 and 2022. **Methods:** Cross-sectional, retrospective, and descriptive study, with data from the Notifiable Diseases Information System (SINAN) and DataSUS. Notifications of pulmonary TB in children aged 0 to 14 years were analyzed, with emphasis on the diagnostic methods used and clinical outcomes. **Results:** The incidence of TB ranged from 1.18 to 2.34 cases per 100,000 inhabitants. MRT-TB showed increasing use, with improved sensitivity after the introduction of Xpert MTB/RIF Ultra. Despite advances, many diagnoses still occur without laboratory confirmation. The highest cure rate (91.79%) was observed among children aged 5 to 9 years, while those under 1 year had the highest mortality rate (7.38%). **Conclusion:** MRT-TB brought significant benefits to pediatric TB diagnosis, but challenges persist, including low sensitivity in children and barriers to early diagnosis. Further studies are needed to improve diagnostic and therapeutic strategies.

Keywords: Pulmonary tuberculosis; Diagnostic tests; Pediatrics.

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RESUMO

Introdução: A tuberculose (TB), causada pelo *Mycobacterium tuberculosis*, permanece um desafio de saúde pública global. O Brasil, listado entre os 30 países com maior carga de TB, registra alta morbimortalidade, especialmente em crianças menores de 15 anos. O diagnóstico precoce em pediatria é dificultado pela inespecificidade dos sintomas e baixa sensibilidade dos testes laboratoriais. Desde 2015, o Teste Rápido Molecular para Tuberculose (TRM-TB) tem sido implementado no Brasil, com avanços significativos no diagnóstico. **Objetivo:** Avaliar a eficácia do TRM-TB no diagnóstico de TB pulmonar pediátrica em Minas Gerais e seu impacto na notificação da doença entre 2007 e 2022. **Métodos:** Estudo transversal, retrospectivo e descritivo, com dados do Sistema de Informação de Agravos de Notificação (SINAN) e do DataSUS. Foram analisadas notificações de TB pulmonar em crianças de 0 a 14 anos, com ênfase nos métodos diagnósticos utilizados e nos desfechos clínicos. **Resultados:** A incidência de TB variou entre 1,18 e 2,34 casos por 100.000 habitantes. O TRM-TB apresentou crescente utilização, com sensibilidade aprimorada após a introdução do Xpert MTB/RIF Ultra. Apesar de avanços, muitos diagnósticos ainda ocorrem sem confirmação laboratorial. Observou-se maior taxa de cura (91,79%) entre crianças de 5 a 9 anos, enquanto menores de 1 ano apresentaram maior mortalidade (7,38%). **Conclusão:** O TRM-TB trouxe benefícios significativos para o diagnóstico pediátrico de TB, mas desafios persistem, incluindo a baixa sensibilidade em crianças e as barreiras ao diagnóstico precoce. Estudos futuros são necessários para aprimorar estratégias diagnósticas e terapêuticas.

Palavras-chave: Tuberculose pulmonar; Testes diagnósticos; Pediatria.

Introduction

Tuberculosis (TB) is an infectious disease caused by *Mycobacterium tuberculosis* and represents a major challenge for global public health. According to the World Health Organization (WHO), Brazil is among the 30 countries with the highest TB burden in the world, with 5,845 TB-related deaths recorded in 2022 nationwide and more than 130 cases in the state of Minas Gerais[1,2]. It is estimated that children and adolescents under 15 years of age account for 11% of global TB cases, which equates to 1.1 million cases per year[2].

According to the Epidemiological Bulletin, in 2022, TB was the second leading cause of death by infectious agents in Brazil, with a mortality rate of 2.72 deaths per 100,000 inhabitants[1]. In 2024, the state of Minas Gerais recorded an incidence of 19.9 new TB cases per 100,000 inhabitants, with a mortality rate of 1.6 deaths per 100,000 inhabitants[3].

In this study, we address pulmonary TB, specifically in the pediatric population up to 14 years old. Infection is most common in children aged 1 to 4 years and presents a higher risk of developing severe and disseminated forms in those under 2 years old, with high morbidity and mortality. In adolescents, it presents clinically similar to adult TB[2].

The major challenge of pediatric TB is early diagnosis, which is essential to prevent severe forms and deaths. However, nonspecific signs and symptoms, similarity with other common childhood diseases, and the paucibacillary nature of the infection hinder this process. Furthermore, the available diagnostic tests, traditionally used in adults, show low sensitivity and specificity in children, aggravated by the difficulty in obtaining suitable samples[4]. In particular, depending on the age group, children often cannot produce sputum, making laboratory tests unfeasible, and even when samples are obtained, the low bacillary load compromises the sensitivity of the tests[5].

In Brazil, since 2002, the National Tuberculosis Control Program has recommended that the diagnosis of intrathoracic TB in children be based on a scoring system that includes clinical symptoms, epidemiology, Tuberculin Skin Test (TST) results, radiological examination, and the patient's nutritional status; thus, bacteriological confirmation is not required[6].

Since 2010, WHO has recommended the use of the Rapid Molecular Test for Tuberculosis (MRT-TB) in endemic countries such as Brazil[7]. This test, based on Polymerase Chain Reaction (PCR) technology, can detect *M. tuberculosis* and identify mutations associated with rifampicin resistance in about two hours[7,8]. In Brazil, MRT-TB was incorporated in 2014 as one of the laboratory diagnostic criteria for TB, alongside smear microscopy (BAAR) and culture[9]. Initially, the molecular test used was Xpert MTB/RIF, which, from 2019, was replaced by Xpert MTB/RIF Ultra, providing significant advances[10]. The new version shows improved sensitivity, especially in cases of paucibacillary tuberculosis, more frequent in children and in people living with HIV, allowing for the detection of smaller amounts of bacilli and genetic traces of *M. tuberculosis*, a feature especially valuable in the pediatric population[3,11].

The present study evaluates the effectiveness of the MRT-TB diagnostic test in identifying TB in pediatric patients, analyzing the real impact of its implementation for the diagnosis of pulmonary TB in the Brazilian state of Minas Gerais.

Methods

This is a cross-sectional, retrospective, descriptive-analytical study with a quantitative approach.

Pediatric patients aged 0 to 14 years with a diagnosis of Pulmonary Tuberculosis notified through the Notifiable Diseases Information System (SINAN) in the state of Minas Gerais between 2007 and 2022 were studied. Data was collected through TABNET, a public domain tabulator that provides information from the Unified Health System (SUS) databases. Additionally, general population data for Minas Gerais, specifically the target population of the study, were obtained from preliminary population estimates prepared by the Ministry of Health (2000–2021). For 2022, population data were obtained from the projections of the population of Brazil and Federation Units by sex and age for the period 2010–2060 (2018 edition) by the Brazilian Institute of Geography and Statistics (IBGE).

Patients aged 0 to 14 years notified with pulmonary TB in Minas Gerais were included. Cases not within the established age group or diagnosed with extrapulmonary forms of the disease were excluded. The following variables were analyzed: year of notification (2007–2022) in Minas Gerais, age group, diagnosis of pulmonary tuberculosis, laboratory confirmation, sputum smear results, culture, and rapid molecular test for tuberculosis (MRT-TB), as well as recorded outcomes, classified as cure, abandonment, death from tuberculosis, death from other causes, transfer, drug-resistant tuberculosis (TB-DR), failure, and primary abandonment.

In the SINAN notification context, TB cure is considered when there is an absence of *Mycobacterium tuberculosis* in the patient's body, evaluated by a health professional through clinical and laboratory confirmation. For cases with bacteriological confirmation at the start of treatment, cure is considered when at least two negative sputum smears are obtained at the end of therapy, one of which must be performed in the final phase of treatment[12]. This concept aligns with the WHO definition, which also considers a patient is cured with smear-positive pulmonary TB who presents negative sputum smears in at least two samples, including one at the end of treatment[13]. Additionally, WHO uses the "treatment success" indicator, which includes both cases classified as cured and those who completed treatment, even without final bacteriological confirmation. However, in the database used in this study, only the "cure" variable was considered to assess favorable outcomes[13].

Regarding MRT-TB, in this study of patients aged 0 to 14 years with pulmonary TB, the detection of *Mycobacterium tuberculosis* in traces, with indeterminate resistance, was considered positive for TB in children under 10 years. For patients aged 10 to 14 years, this result was classified as inconclusive. The detection of bacilli with undetected rifampicin resistance was considered indicative of tuberculosis without resistance, while detection with identified resistance was interpreted as rifampicin-resistant tuberculosis. Unconcluded, invalid, or error results were classified as inconclusive[14].

A detailed analysis of the DataSUS database was conducted, obtaining accurate information on patients with positive results for pulmonary TB, the diagnostic tests used, and patient outcomes.

Results

During the analysis period (2007–2022), data were obtained on the total population aged 0 to 14 years in Minas Gerais and the number of notifications of pulmonary TB in the same age group. From these data, the incidence of the disease by age group was calculated, expressed in cases per 100,000 inhabitants (Graph 1). According to the WHO definition, individuals under 10 years old are classified as children, while those aged 10 to 19 years are considered adolescents[15]. In this study, this classification was adopted, with children considered as patients aged 0 to 9 years and adolescents as those aged 10 to 14 years.

The highest incidence was recorded in 2022, with 2.34 cases per 100,000 inhabitants, and the lowest in 2015, with 1.18 cases per 100,000 inhabitants. Over the analyzed period, a trend toward stability was observed. Children under 10 presented higher and more fluctuating rates, while adolescents 10-14 showed lower and more stable rates.

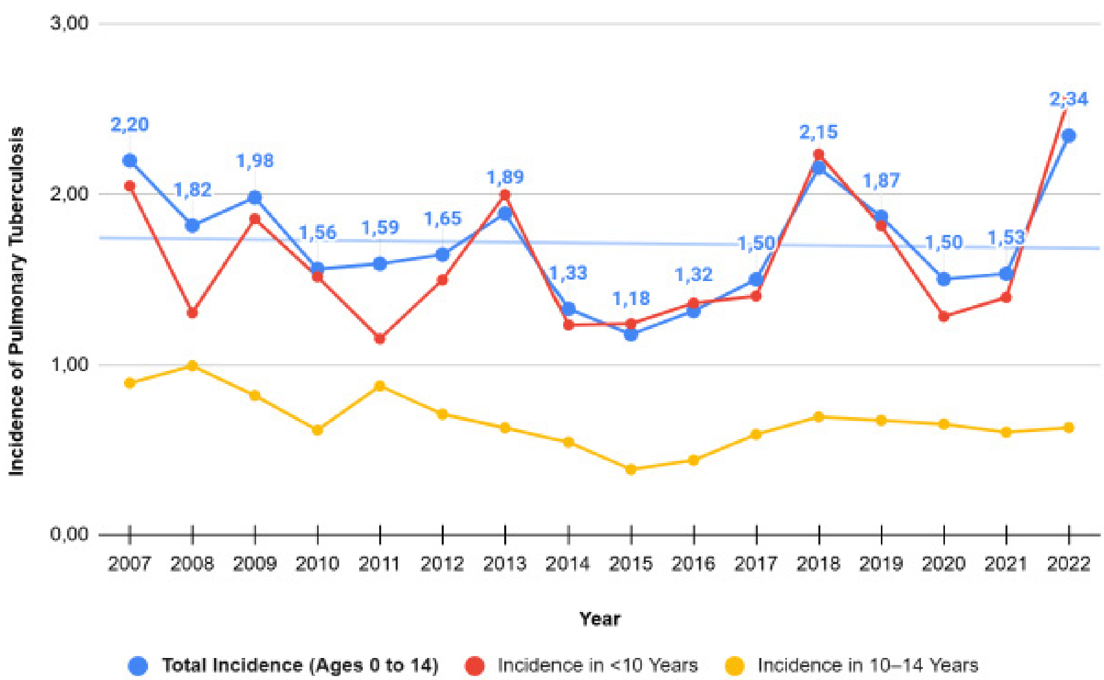
Next, the number of microbiological diagnostic tests performed each year during the study period, including smear microscopy (BAAR), sputum culture, and MRT-TB, is presented (Graph 2).

It is possible to observe a growth in the performance of MRT-TB over the years, since its incorporation into SUS in 2015, with an ascending trend line. Sputum culture tests also increased during the evaluated period. BAAR was the most used test in all years except 2022.

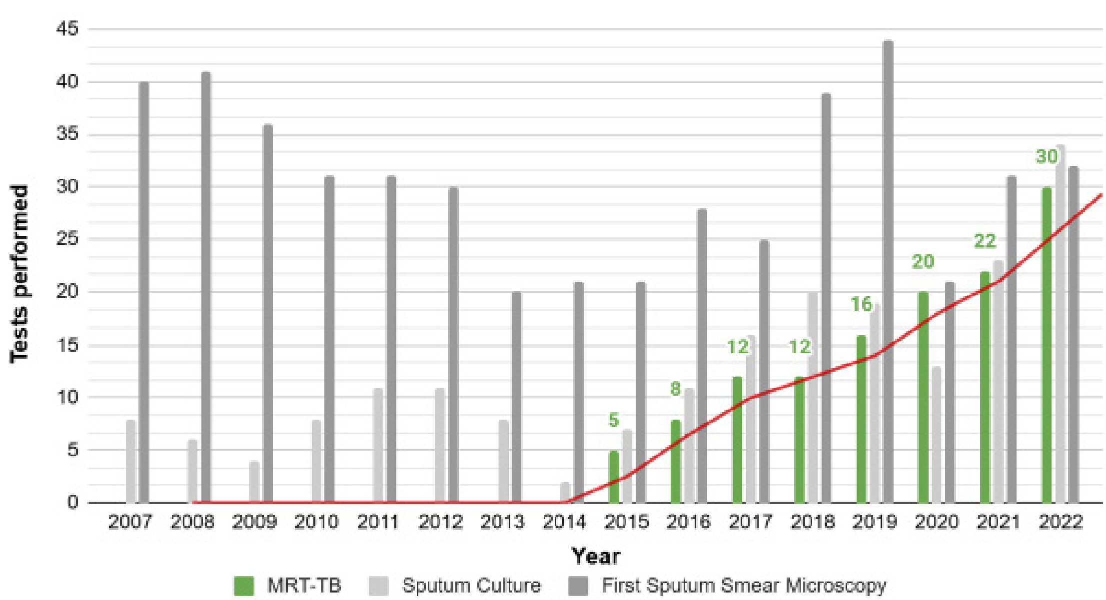
Regarding laboratory diagnostic confirmation, the number of notifications of pulmonary TB in the population aged 0 to 14 years with microbiological confirmation was identified, as well as cases diagnosed based on clinical-radiological-laboratory scoring without microbiological confirmation. From these data, by age group, the percentage of cases with laboratory confirmation relative to total notified cases was calculated, shown in Graph 3.

From 2007 to 2022, the percentage of laboratory-confirmed cases varied distinctly between age groups. The 10–14-year-old group presented the highest percentages, generally between 50% and 75%, reaching 60.0% in 2022. Children under 1 had larger oscillations, reaching 61.9% in the last analyzed year. For ages 5–9, a growth trend was observed (16.7% in 2007, up to 33.3% in 2022). Ages 1–4 maintained the lowest rates, but with a slight recent increase (16.1% in 2022).

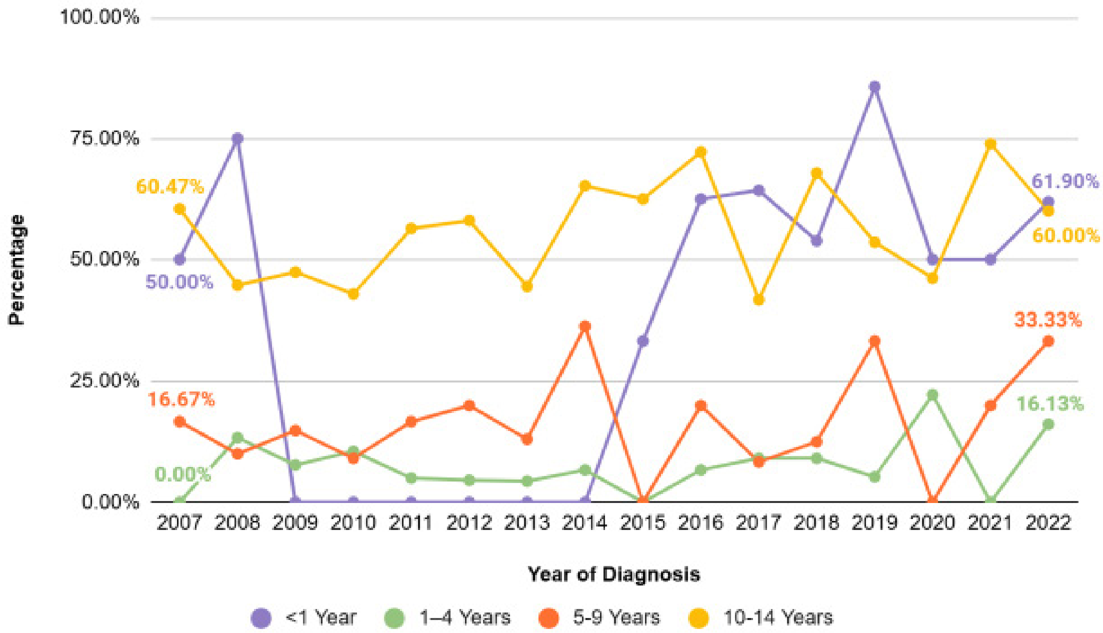
Specifically for MRT-TB, the results for all tests performed from 2015 to 2022 are shown in Table 1.



Graph 1. Incidence of pulmonary tuberculosis in children and adolescents aged 0 to 14 years in Minas Gerais: rates per 100,000 inhabitants by age group and year.



Graph 2. Comparison of the Number of MRT-TB, Sputum Culture, and First Sputum Smear Microscopy Tests Performed in the Pediatric Population Aged 0 to 14 Years from 2007 to 2022.



Graph 3. Percentage of Laboratory-Confirmed Pulmonary TB Cases by Age Group and Year of Diagnosis. Minas Gerais 2007-2022.

Table 1. Results of MRT-TB in Pediatric Population, by Age Group, 2015–2022, Minas Gerais.

Age group: Under 10 years						
Year	**Positive Test**		**Negative (Not detectable)**	**Inconclusive**	**Total tests**	**Positivity rate**
	Rifampicin-sensitive	**Rifampicin-resistant**				
2015	2	-	2	-	4	50.0%
2016	2	-	2	0	4	50.0%
2017	2	1	3	1	7	42.8%
2018	2	-	3	-	5	40.0%
2019	2	-	4	2	8	25.0%
2020	8	-	2	1	11	72.7%
2021	5	-	3	2	10	50.0%
2022	11	-	5	3	19	57.8%
TOTAL	34	1	24	9	68	64.0%
Age group: 10–14 years						
Year	**Positive Test**		**Negative (Not detectable)**	**Inconclusive**	**Total tests**	**Positivity rate**
	Rifampicin-sensitive	**Rifampicin-resistant**				
2015	-	-	1	-	1	0.0%
2016	3	-	-	1	4	7.,0%
2017	4	-	1	-	5	80.0%
2018	4	-	3	-	7	57.1%
2019	4	1	2	1	8	62.5%
2020	5	-	3	1	9	55.5%
2021	9	1	-	-	10	100%
2022	7	-	-	-	7	100%
TOTAL	36	2	10	3	51	74.5%

Note: With the introduction of Xpert MTB/RIF Ultra in 2019, the previous version (Xpert MTB/RIF) was discontinued. In this study, the detection of *M. tuberculosis* as "trace" was considered positive for tuberculosis in children under 10 years and inconclusive in patients aged 10–14 years.

For children under 10, 68 tests were performed, with 34 (50.0%) detecting rifampicin-sensitive *M. tuberculosis* and 1 (1.5%) case of resistance. According to the study's criteria, which classifies "trace" as positive in this group, the overall positivity rate was 64.0%. An upward trend was observed, reaching 72.7% in 2020. On the other hand, 24 tests (35.3%) were negative and 9 (13.2%) inconclusive.

Among patients aged 10–14 years, 51 tests were performed, with 36 (70.6%) positive for rifampicin-sensitive *M. tuberculosis* and 2 (3.9%) cases of resistance. The global positivity rate was 74.5%, higher than in the younger age group. There were 3 (5.8%) inconclusive and 10 (19.6%) negative results. A gradual increase in positivity was seen, reaching 100% in 2021 and 2022.

Next, the outcomes for patients diagnosed with pulmonary TB, categorized by age group, are presented (Table 2).

Discussion

The study began with the analysis of epidemiological data on pulmonary TB in the target population, aiming to understand and interpret the number of cases of the disease and the impact of diagnostic tests on notifications.

Regarding the incidence of pulmonary TB, a reduction was observed in the years 2019, 2020, and 2021 when compared to 2018, a year in which the rate was 2.15 cases per 100,000 inhabitants. In the following three years, incidence rates per 100,000 inhabitants were 1.87 in 2019, 1.50 in 2020, and 1.53 in 2021, a period impacted by the COVID-19 pandemic. The hypothesis of underreporting during the pandemic may explain this observed reduction, since social isolation, the constant use of masks, and the emergence of respiratory conditions with symptoms similar to those of TB, COVID-19, and other respiratory diseases may have hindered accurate diagnosis and, consequently, the notification of pulmonary TB cases. Therefore, data for the years 2019 to 2021 cannot be considered a faithful representation of the true incidence of the disease due to underdiagnosis and underreporting in this period[8].

In 2022, the incidence of pulmonary TB increased again, reaching its highest value since 2007, with 2.34 per 100,000 inhabitants. The interpretation that, in 2022, with the drastic reduction in social isolation measures, greater relaxation of rules, a decline in COVID-19 cases, and increased vaccination coverage against SARS-CoV-2, there was an adjustment in the identification and notification of other respiratory infections, including pulmonary TB, allows us to consider the incidence for this year a real quantitative number[16-18].

Analyzing Graph 2, between 2007 and 2014, only two tests were mainly used: sputum culture and sputum smear microscopy (BAAR). After 2014, Xpert MTB-Rif (MRT-TB) was incorporated as another diagnostic test in the Brazilian Unified Health System (SUS), which since then has shown a gradual increase in use. From 2020 onward, there is a balance among the three tests performed and presented on the notification forms, which reach similar numbers in 2022 (30 MRT-TB performed, 34 cultures, and 32 BAAR). However, BAAR was the most used test in all years from 2007 to 2021, except in 2022, when sputum culture was performed most frequently.

Graph 3 reveals important trends in the microbiological confirmation of pulmonary tuberculosis in the pediatric and adolescent population of the state. Data analysis demonstrates clear variation among age groups, with notably higher laboratory positivity among adolescents (10 to 14 years old) compared to children under 10 years old.

Overall, adolescents consistently showed the highest rates of laboratory confirmation throughout the period analyzed, frequently above 50% and in some years exceeding 70%. This pattern is compatible with the clinical presentation of TB in this age group, which tends to resemble the adult form of the disease, with a higher bacillary load, more frequent pulmonary cavitation, and greater ability to expectorate, facilitating bacillus detection both by smear microscopy and molecular tests[19]. Among children, especially those under 5 years old — and most notably those under 1 year — laboratory confirmation rates were systematically lower. In many years, especially before 2014, these groups recorded rates close to 0%, reflecting the well-known challenges of microbiological diagnosis in this population. In young children, TB is generally paucibacillary, with less bacillus elimination, which reduces the sensitivity of traditional

Table 2. Outcomes of Patients Notified with Pulmonary TB (2007–2022) by Age Group, Minas Gerais

	Age group			
	<1 year	**1–4 years**	**5–9 years**	**10–14 years**
Cure	92 (61.74%)	240 (81.63%)	246 (91.79%)	401 (86.42%)
Death from TB	11 (7.38%)	1 (0.34%)	1 (0.37%)	3 (0.65%)
Abandonment	16 (10.74%)	30 (10.20%)	12 (4.48%)	29 (6.25%)
TB-DR	1 (0.67%)	0 (0.0%)	0 (0.0%)	2 (0.43%)
Other outcomes	29 (19.46%)	23 (7.82%)	9 (3.36%)	29 (6.25%)
TOTAL	149	294	268	464

Legend: TB-DR = Drug-resistant tuberculosis; Other outcomes = Includes "Ignored/Blank," "Death from other causes," "Transfer," "Change of regimen," and "Failure."

diagnostic methods[20]. In addition, most of these children are unable to produce sputum, making it necessary to collect alternative samples, such as gastric lavage, nasopharyngeal aspiration, or induced sputum, which are technically more complex procedures that require specific facilities and training[21]. It is important to note that, in this study, as it is based on notification data, it is not possible to identify which type of sample was used for diagnosis in each patient. Still, as expected, the younger the age, the lower the positivity rate tends to be.

However, from 2015 onwards, there was a marked increase in the percentage of laboratory positivity among children under 1 year of age, a pattern that was not expected considering the factors previously discussed. Notably, in 2022, the proportion of tuberculosis cases confirmed by laboratory testing exceeded 60%. This finding, however, should be interpreted with caution. Over the entire study period, only 141 cases were recorded in this age group, with 21 cases reported in 2022, of which 13 (61.9%) were laboratory-confirmed. The small number of cases, particularly when considering annual analyses, may lead to an overestimation of the observed proportions, representing a limitation to the generalization of these results to the infant population in this age group.

The discussion about laboratory confirmation data can be enriched by dividing the analyzed period into three distinct phases, related to the introduction and improvement of molecular diagnostic methods.

In the first period, from 2007 to 2013, before the incorporation of MRT-TB, laboratory diagnosis was based exclusively on smear microscopy and culture. During this interval, laboratory confirmation rates among children under 5 years were extremely low, as evidenced in Graph 3, and only adolescents had considerable positivity rates, reflecting the limitations of the available methods at the time.

The second phase, from 2014 to 2018, corresponds to the period of implementation of MRT-TB (Xpert MTB/RIF), incorporated into SUS in 2014[22]. The introduction of this molecular method represented a considerable advance, especially in the pediatric population. From 2015 onward, an increase in positivity is observed in all age groups, including the younger children, although rates remain low in the youngest groups. Table 1 confirms this trend: between 2016 and 2018, positivity rates among children under 10 ranged from 25% to 50%, still low but higher than previous periods.

The third phase, from 2019 onward, reflects the period of use of Xpert MTB/RIF Ultra, an improved version of MRT, with significantly higher sensitivity. This new version allows for the detection of smaller quantities of bacilli and genetic fragments ("traces") of *M. tuberculosis*, being especially useful in children and people living with HIV[3,14,23].

Table 1 reinforces this trend. From 2019 onward, positivity among children under 10 reaches 45% in 2019 and 75% in 2020, remaining high in 2021 (72.7%). The year 2022 also stands out, with a positivity rate of 57.8% in this age group. Patients aged 10 to 14, in turn, show consistently higher positivity throughout the period: 75% in 2016, 57.1% in 2017, and reaching 85.7% in 2022. Overall positivity between 2015 and 2022 was 74.5% for adolescents, compared to 59% for those under 10.

Given this variation in positivity according to age, the National Tuberculosis Control Program recommends different diagnostic approaches for each age group. In children, culture is recommended even in cases with a negative MRT-TB result, due to the limitations of the test in this population. In adolescents, culture is indicated only when MRT-TB is positive, as the clinical presentation and test positivity tend to be more reliable in this age group[14-17].

Regarding patient outcomes, as shown in Table 2, a lower cure rate was identified in the age group under 1 year, with 92 cures (61.74%) among 149 patients. Cure rates increased in the 1–4, 5–9, and 10–14 age groups, with 240 cures (81.63%) in 294 patients, 246 cures (91.79%) in 268 patients, and 401 cures (86.42%) in 464 patients, respectively. As for the number of deaths, a higher number was observed among those under 1 year, with 11 deaths recorded (7.38%), while in other age groups, deaths were lower: 1 death (0.34%) in children aged 1–4 years, 1 (0.37%) in those aged 5–9 years, and 3 (0.65%) in adolescents aged 10–14 years. These findings are consistent with other studies showing higher mortality in this age group and highlight the vulnerability of children under 1 year, who have a greater risk of severe forms of the disease and, consequently, higher morbidity and mortality[24].

Additionally, a significant number of treatment abandonments were observed, especially in the age groups under 1 year (10.74%) and 1–4 years (10.20%). Treatment abandonment may be explained by the prolonged duration of treatment, medication side effects, complexity of the therapeutic regimen, and socioeconomic factors impacting treatment adherence. Such abandonment is an unfavorable factor, as it increases the risk of complications, TB transmission, and the development of drug resistance[25,26].

Finally, the incidence of drug-resistant TB (TB-DR) was low, with only 1 case (0.67%) recorded in children under 1 year and 2 cases (0.43%) in the 10–14-year group. This suggests that TB-DR does not have a high prevalence in the state of Minas Gerais. However, drug resistance, including rifampicin resistance, is a significant concern in other regions of Brazil, such as the state of Rio Grande do Sul, where TB-DR is more prevalent[27,28]. Therefore, ongoing surveillance is essential to better understand the dynamics of resistance in the pediatric population.

Conclusion

The implementation of the Rapid Molecular Test for Tuberculosis (MRT-TB) represented a significant milestone in the diagnosis of childhood TB, especially in an endemic state such as Minas Gerais. Since its incorporation, an increase in laboratory confirmation rates has been observed, which has direct implications for the selection and early initiation of appropriate treatment.

Despite these advances, further studies are needed to identify complementary strategies that enhance diagnostic sensitivity in more vulnerable age groups. The ongoing improvement of childhood TB diagnosis requires the integration of technological innovation, professional training, and the strengthening of the healthcare network.

Study limitations

In terms of generalization, the results of this study apply mainly to the pediatric population treated within the Brazilian Unified Health System (SUS) in the state of Minas Gerais, reflecting public health policies and the technological advancement of diagnostic tests over the past decade. However, the data may not be fully representative of all regions of the state, especially in areas with less access to resources and health services, which can affect the accuracy and coverage of diagnosis and treatment. Limitations in access to diagnostic tests in certain regions may, therefore, compromise the applicability of the results in different contexts.

Authors' Contributions

We describe contributions to the papers using the taxonomy (CRediT) provided above: *Conceptualization, Investigation, Methodology, Visualization & Writing – review & editing*: ALL Jimenez; ARB Araújo; AHS Sathler. *Project administration, Supervision & Writing – original draft*: ALL Jimenez; ARB Araújo; DO Russo; TMS Candiani; LMO Diniz. *Validation & Software*: ALL Jimenez. *Data curation & Formal Analysis*: DO Russo; TMS Candiani.

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