

INFLUENCE OF THE COVID-19 PANDEMIC ON TUBERCULOSIS VACCINATION COVERAGE: AN EPIDEMIOLOGICAL APPROACH

INFLUÊNCIA DA PANDEMIA DA COVID-19 NA COBERTURA VACINAL DA TUBERCULOSE: UMA ABORDAGEM EPIDEMIOLÓGICA

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ABSTRACT

Tuberculosis is a public health problem that affects millions of people worldwide and causes thousands of deaths annually. With the COVID-19 pandemic, the global scenario was drastically affected, including vaccination coverage against tuberculosis. The BCG (*Bacillus Calmette-Guérin*) vaccine plays a fundamental role in controlling tuberculosis in endemic areas, especially in children. Thus, this study investigates BCG vaccination coverage during the COVID-19 pandemic, correlating it with the number of tuberculosis cases in children under 1 year of age, up to 4 years old. An epidemiological survey was conducted using data collected from the DATASUS platform. The study observed a 10.9% increase in the emergence of new tuberculosis cases in 2022 compared to 2019 in Brazilian territory. The reduction in vaccination coverage in 2019, 2020, and 2021 led to an increase in tuberculosis cases in children under 1 year and among those aged 1–4 years. Therefore, the overall picture of vaccination rates and case numbers reinforces the importance of awareness and the need to strengthen public immunization policies, as well as combat misinformation, aiming to protect child health and reduce morbidity and mortality rates associated with tuberculosis in Brazil.

Keywords: BCG; SARS-CoV-2; Immunization.

RESUMO

A tuberculose é um problema de saúde pública, que afeta milhões de pessoas pelo mundo e causa milhares de mortes anualmente. Com a pandemia da COVID-19, o cenário global foi drasticamente afetado, incluindo a cobertura vacinal contra a tuberculose. A vacina BCG (*Bacillus Calmette-Guérin*), desempenha um papel fundamental no controle da tuberculose em áreas endêmicas, especialmente em crianças. Assim, o trabalho investiga a cobertura

vacinal da BCG durante a pandemia da COVID-19, correlacionando-a com o número de casos de tuberculose em crianças menores de 1 ano, até os 4 anos de idade. Foi realizada uma pesquisa epidemiológica, utilizando dados coletados da plataforma DATASUS. O estudo observou um aumento de 10,9% no surgimento de novos casos de tuberculose no ano de 2022, em comparativo ao ano de 2019 no território brasileiro. A redução da cobertura vacinal nos anos 2019, 2020 e 2021, levou ao aumento de tuberculose em crianças menores de 1 ano e entre 1-4 anos. Assim, o panorama geral sobre as taxas de vacinação e números de casos reforça a importância da conscientização e a necessidade do fortalecimento das políticas públicas de imunização, bem como o combate à desinformação, com vistas à proteção da saúde infantil e à redução dos índices de morbidade e mortalidade associados à tuberculose no Brasil.

Palavras-chave: BCG; SARS-CoV-2; Imunização.

1. INTRODUCTION

Tuberculosis is an infectious disease caused by *Mycobacterium tuberculosis*, which can manifest through the respiratory tract (pulmonary tuberculosis) or disseminate to other organs (extrapulmonary tuberculosis) (De Siqueira, 2012). Symptoms of tuberculosis include dry or productive cough, sputum production with mucus or blood, night sweats, fever, tiredness accompanied by fatigue, weight loss, chest discomfort, and difficulty breathing. The disease can also be transmitted through respiratory droplets from infected patients (Poletto, 2017).

In Brazil, the Ministry of Health recorded 5,072 deaths from tuberculosis in 2021 (per 100,000 inhabitants), representing the highest figure recorded in the previous ten years and constituting a

significant public health concern (Brasil, 2023a). Despite advances in diagnosis and treatment, tuberculosis remains a major challenge, particularly among children under five years of age, who are more susceptible to severe forms of the disease, such as tuberculous meningitis and miliary tuberculosis (Brasil, 2024; Campos et al., 2006).

The *Bacillus Calmette–Guérin* (BCG) vaccine is the primary preventive strategy against severe forms of tuberculosis in children. In Brazil, BCG vaccination is routinely administered to newborns or to children up to five years of age (Pinheiro de Souza et al., 2015). Despite its importance, Brazil has experienced a decline in BCG vaccination coverage, as well as in coverage for poliomyelitis and the measles, mumps, and rubella (MMR) vaccine (Arroyo et al., 2020).

Considering the available data, it is important to highlight the state of public calamity declared in 2020 due to the COVID-19 pandemic, which allowed state and municipal governments to implement lockdown measures as a strategy to contain the spread of SARS-CoV-2 (Ottoni et al., 2024; Braga et al., 2024; Orfão et al., 2021). The pandemic resulted in several negative impacts on health and the economy, particularly the saturation of healthcare systems due to the large number of cases and difficulties in the supply of hospital materials and resources (Ottoni et al., 2024; Braga et al., 2024; Orfão et al., 2021).

2. METHODOLOGY

An epidemiological, quantitative, descriptive, and correlational study was conducted using data collected from the DATASUS platform. To analyze BCG vaccination coverage, data from 2017 to 2022 were

considered and stratified by geographic region (North, Northeast, Southeast, South, and Central-West). Regarding confirmed tuberculosis cases, records from 2017 to 2023 were analyzed and stratified both by reporting region and age group, specifically including children under 1 year of age and children aged 1 to 4 years.

The inclusion criteria comprised all data available in DATASUS regarding BCG vaccination coverage and confirmed tuberculosis cases among children under 1 year of age and those aged 1 to 4 years during the period from 2017 to 2023. Incomplete or inconsistent records were excluded, including those lacking information on age group, region, or year of diagnosis, as well as duplicate records or records containing evident reporting errors.

In addition to the collection of secondary data, a literature search was conducted in the BVS, PubMed, Google Scholar, and SciELO databases using the following descriptors and keywords, in Portuguese and English: “tuberculosis,” “vaccination,” “BCG,” “children,” “pandemic,” “COVID-19,” “*lockdown*,” “pediatric,” “social isolation,” “risks,” “vaccination coverage,” “*tuberculosis*,” “*children*,” and “*clinical forms*.”

3. RESULTS AND DISCUSSION

Considering the reported data, 2017 and 2018 stood out for having the highest numbers of individuals vaccinated with BCG (481,512 and 487,153, respectively) and the lowest numbers of confirmed tuberculosis cases among children under one year of age (378 and 418 cases, respectively) (Figure 1A and B). However, the number of confirmed cases among children aged 1–4 years during the same period was already considered high (571 and 640 cases, respectively),

reaching 669 cases in 2019 and subsequently declining to 386 cases in 2020 (Figure 1B).

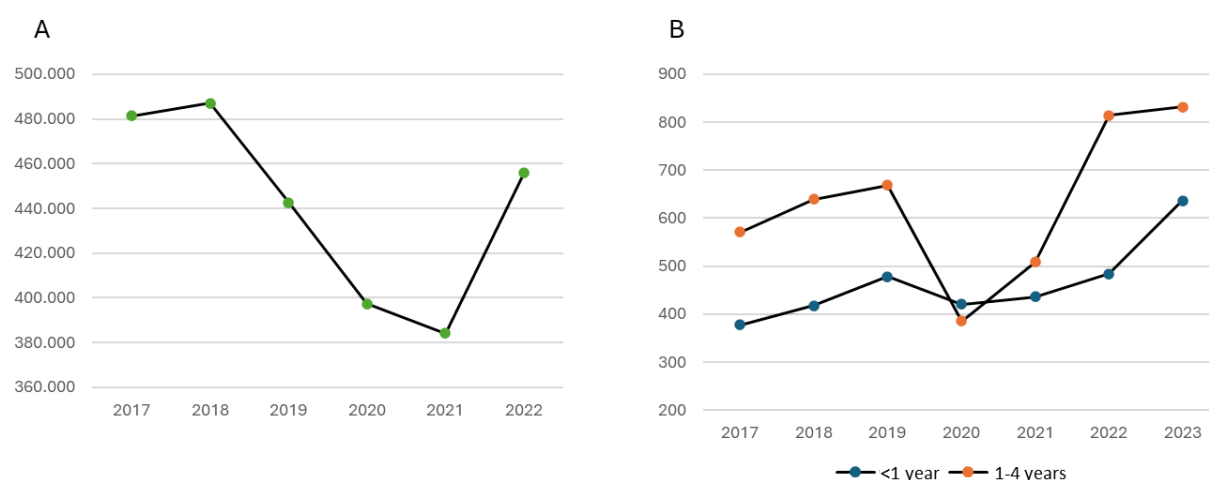


Figure 1. Analysis of BCG vaccination coverage and the total number of tuberculosis cases in Brazil. (A) Absolute vaccination data from 2017 to 2022. (B) Total number of confirmed cases according to the year of diagnosis among children aged <1 year and 1–4 years from 2017 to 2023. Source: Ministry of Health/SVSA – Notifiable Diseases Information System (Sistema de Informação de Agravos de Notificação – SINAN Net), 2024.

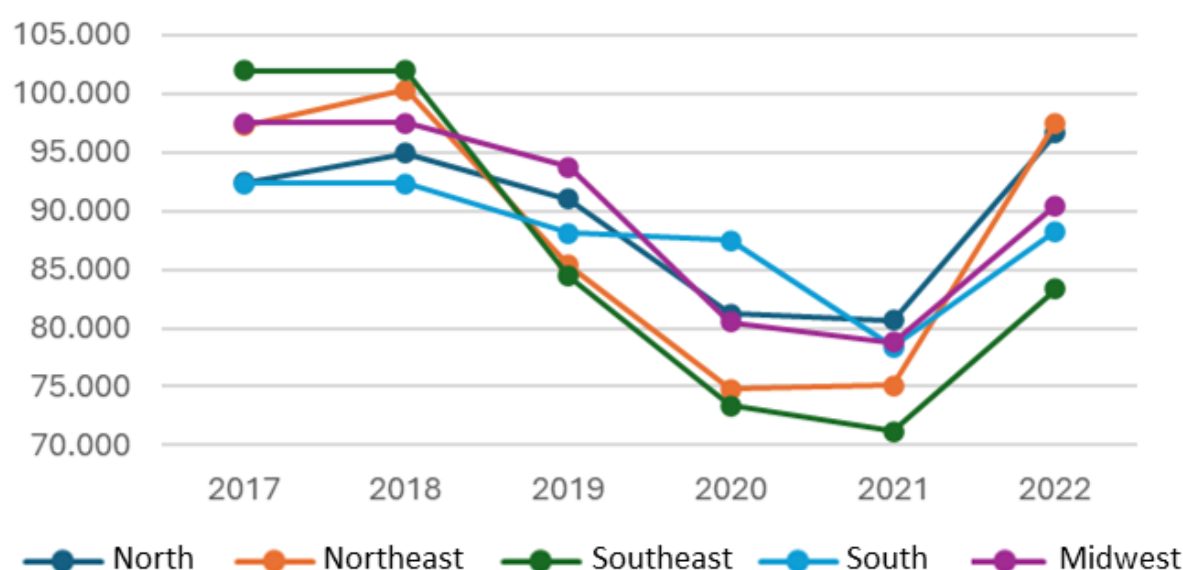


Figure 2. BCG vaccination coverage by geographic region in Brazil from 2017 to 2022. Source: Ministry of Health/SVSA – Notifiable Diseases Information System (Sistema de Informação de Agravos de Notificação – SINAN Net), 2024.

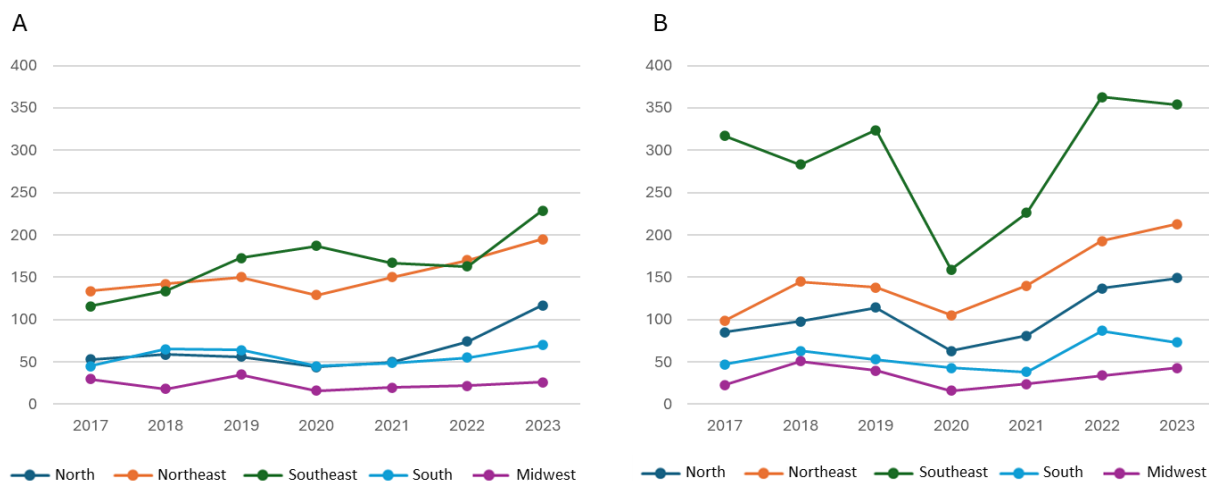


Figure 3. Confirmed tuberculosis cases by reporting region from 2017 to 2023. (A) Children <1 year of age; (B) children aged 1–4 years. Source: Ministry of Health/SVSA – Notifiable Diseases Information System (Sistema de Informação de Agravos de Notificação – SINAN Net), 2024.

The reduction in vaccination coverage in 2019, 2020, and 2021 was followed by an increase in tuberculosis cases among children under 1 year of age in the subsequent years, reaching 484 and 637 cases in 2022 and 2023, respectively. Among children aged 1–4 years, 814 and 832 cases were reported in the same years (Figure 1A and B).

The Brazilian regions that recorded the greatest declines in vaccination coverage were the Southeast and Northeast between 2020 (73,410 and 74,830, respectively) and 2021 (71,180 and 75,130, respectively), followed by an increase in tuberculosis cases among children under 1 year of age in 2022 (163 and 170 cases) and 2023 (229 and 195 cases). An increase was also observed among children aged 1–4 years, with 363 and 193 cases in 2022 and 354 and 213 cases in 2023, respectively (Figures 2 and 3).

In 2022, vaccination coverage was restored across all Brazilian regions (North, Northeast, Central-West, South, and Southeast), reaching a total of 456,110 vaccinations nationwide. However, this

figure remained 5.27% and 6.37% lower than the levels recorded in the pre-pandemic years of 2017 and 2018, respectively (Figures 1A and 2).

This study investigated BCG vaccination coverage during the COVID-19 pandemic and its association with the number of tuberculosis cases among children under 1 year of age and children up to 4 years of age.

During this period, disruptions in healthcare services and the dissemination of *fake news* regarding vaccination resulted in a marked decline in overall immunization rates in Brazil and other countries (Procianoy et al., 2022), including BCG vaccination. Another important factor to consider is the impact on the capacity of healthcare services to detect and diagnose tuberculosis cases, resulting in disease underreporting (Brasil, 2024). This scenario seriously compromised the progress achieved in recent years toward the control and elimination of tuberculosis in Brazil. Consequently, an increase in pediatric tuberculosis cases was observed in the population.

The dissemination of *fake news* and public perceptions of vaccination were investigated by Castelfranchi et al. (2025), who examined their association with educational attainment and scientific knowledge, despite the fact that respondents generally expressed a positive view of immunization. In this context, providing accurate information and raising public awareness remain fundamental and important measures for the prevention of infectious diseases.

The significant reduction in BCG vaccination rates in 2020 and 2021 was followed by a progressive increase in confirmed tuberculosis cases in 2022. There was a 10.9% increase in the proportion of notifications compared with 2019. This increase may be attributed to the high vaccination coverage observed in 2017 and 2018, which continued to provide protection to children in 2019.

The increase in pediatric tuberculosis cases may be attributed not only to the decline in BCG vaccination coverage but also to the social conditions exacerbated during the COVID-19 pandemic. Social isolation and the proper use of masks, recommended as preventive measures, were often neglected by families, representing a relevant factor contributing to the exposure of vulnerable children. Furthermore, given that tuberculosis transmission is facilitated among individuals sharing the same household environment, social isolation measures may have increased the risk of intrafamilial transmission (Brasil, 2024).

The distribution of new cases by age group further highlights these impacts, as demonstrated in the epidemiological bulletin. In 2020, the first year of the pandemic, the greatest proportional reduction in notifications was observed, approximately 30% among children up to 9 years of age and 20% among adolescents aged 10–18 years. In 2022, however, there was a 16% increase in the number of new cases among children up to 4 years of age (Brasil, 2024). Considering that BCG is preferably administered to newborns and that vaccination may also be provided up to 5 years of age, children in this age group represent the population most susceptible to developing the disease.

Furthermore, the economic crisis and inadequate access to sufficient and nutritious food among socioeconomically disadvantaged families are additional factors that may contribute to impaired immune function in children. The combination of these factors may help explain the marked increase in the incidence of pediatric tuberculosis observed during the pandemic and post-pandemic periods (Brito et al., 2021; Reinaldo et al., 2020; Orfão et al., 2021).

According to the Ministry of Health, during the pandemic, Brazil recorded approximately 8 million new COVID-19 cases in 2020, 15 million in 2021, and 14 million in 2022 (Brasil, 2025). The Northeast and Southeast regions recorded the highest numbers of new cases, with 9,712 and 3,601 reported cases, respectively (Brasil, 2025). Thus, the difficulties faced by public health sectors in maintaining preventive measures among the population are evident, particularly in the Southeast and Northeast regions, which also reported the highest numbers of pediatric tuberculosis cases.

States such as Espírito Santo (63%), Rio de Janeiro (76%), and São Paulo (82%) failed to reach the 90% vaccination coverage target in 2022 (Brasil, 2023b). This regional scenario reveals structural inequalities in access to vaccines, as well as logistical deficiencies exacerbated during the public health emergency (Dos Santos; Guerra, 2024).

The Southeast region, although the most affected, had led the national immunization ranking prior to the disruption of public health services in the country. Thus, reflecting the decline in vaccination coverage, Brazil recorded an increase in the number of tuberculosis-related deaths for the first time in a decade (Pires et al.,

2023). This discussion can be extended to the decline in other immunization rates nationwide during the pandemic. Overall, the pandemic contributed to an alarming reduction in vaccination uptake in Brazil during the period of social isolation (Da Silva et al., 2016). Measles vaccination coverage, for example, declined substantially during the pandemic, contributing to the emergence of new cases of the disease in the country (Carvalho et al., 2021).

It is important to note that the implementation of restrictive measures, such as social isolation and mask use, should have contributed to reducing the transmission of respiratory diseases such as tuberculosis. However, factors such as inadequate adherence to isolation measures, social inequalities, and insufficient resources within healthcare services may have affected efforts to control pediatric tuberculosis.

It is essential to emphasize the clinical risks associated with pediatric tuberculosis, as the disease may progress rapidly and severely in this age group (Silva et al., 2013). The most common symptoms include persistent fever, cough, weight loss, adynamia (muscle weakness), dyspnea (difficulty breathing), and lymphadenopathy (enlargement of the lymph nodes). Radiographic abnormalities are also frequently observed, including hilar lymphadenopathy, miliary pattern, expansile pneumonia, cavitations, calcifications, pleural effusion, and atelectasis (Silva et al., 2013; Pinheiro et al., 2022). Tuberculosis may present as pulmonary disease, extrapulmonary disease, or a combination of both. In undiagnosed cases or when treatment is initiated late, the disease may progress to death, making early diagnosis and clinical follow-up essential for reducing mortality among children (Silva et al., 2013; Pinheiro et al., 2022).

Although COVID-19 disrupted the healthcare system, the decline in vaccination uptake should not be attributed exclusively to the pandemic. Public misinformation, the strengthening of anti-vaccine movements, and the weakening of public vaccination campaigns were significant factors contributing to vaccine hesitancy (Dos Santos; Guerra, 2024; Pereira et al., 2023).

Therefore, restoring vaccination coverage should be considered a priority, requiring investments in public awareness campaigns, combating misinformation, strengthening primary healthcare, and restructuring health information and logistics systems. The current scenario of pediatric tuberculosis in Brazil reflects not only the COVID-19 health crisis but also underlying vulnerabilities in the National Immunization Program.

CONCLUSION

The decline in BCG vaccination coverage in Brazil, exacerbated during the COVID-19 pandemic, had a direct impact on the increase in pediatric tuberculosis cases, highlighting the vulnerability of the healthcare system in the face of public health crises. The disruption of healthcare services, underreporting, and reduced access to primary healthcare facilities compromised disease prevention and control, particularly among children under five years of age. In this context, strengthening public immunization policies, investing in active surveillance strategies, and ensuring equitable access to healthcare are essential, with particular emphasis on vulnerable populations, in order to prevent setbacks in tuberculosis control efforts in the country.

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