

## Major Article

# Challenges to Schistosomiasis Control Program in Brazil: setbacks in the control program and critical analysis of the disease notification

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### ABSTRACT

**Background:** In 1970, Brazil implemented the Schistosomiasis Control Program (PCE, Portuguese acronym for *Programa de Controle da Esquistossomose*) was implemented in Brazil, where, through successive treatment interventions, the epidemiology and transmission of schistosomiasis have changed significantly over time. This study aimed to evaluate the PCE's effectiveness by critically analyzing the disease notification system.

**Methods:** An ecological study was conducted using data on reported schistosomiasis cases in Brazil between 2007 and 2020.

**Results:** The highest number of municipalities actively participating in the PCE was 750, recorded in 2007. Conversely, participation reached its lowest point in 2020, with only 259 municipalities involved. Over the past decade, there has been a drastic decline in the number of municipalities with active schistosomiasis control programs. During the same period, there was an observed increase in the number of deaths caused by schistosomiasis, while the number of reported cases decreased. This suggests an inverse correlation.

**Conclusions:** The present data suggest that schistosomiasis cases are not correctly diagnosed or reported, reflecting a twisted image of the magnitude of this public health problem in Brazil.

**Keywords:** *Schistosoma mansoni*. Public Health. Epidemiology. Schistosomiasis Surveillance and Control Program. Brazil.

### INTRODUCTION

Schistosomiasis is a widespread parasitic disease affecting approximately 252 million people, reaching 54 countries, mainly Africa and Asia. These estimates suggest that roughly 770 million people live in areas where the disease is endemic and are at risk of infection<sup>1,2</sup>. In Brazil, intestinal schistosomiasis remains a public

health problem, infecting approximately 1.5 million people with an additional 25 million living in at-risk areas<sup>3,4</sup>.

The Global Burden of Disease Study (2017) estimated that schistosomiasis infections caused 1.4 million disability-adjusted life years (DALYs) in Brazil. This ranked schistosomiasis as the second-leading neglected tropical disease in the country in terms of DALYs<sup>5,6</sup>. Furthermore, schistosomiasis was the second most commonly reported parasitic disease in Brazil between 2009 and 2013<sup>7</sup>.

Brazil faces a major public challenge due to schistosomiasis, with a significant number of severe and fatal cases<sup>1</sup>, particularly concentrated in the Northeast and Southeast regions<sup>8</sup>. Endemic areas with historically high infection rates were primarily located in the states of Minas Gerais and Bahia. However, the implementation of the Brazilian Schistosomiasis Control Program (PCE Portuguese acronym for *Programa de Controle da Esquistossomose*), and ongoing treatment interventions have significantly altered the epidemiology and transmission patterns of schistosomiasis<sup>8-10</sup>.

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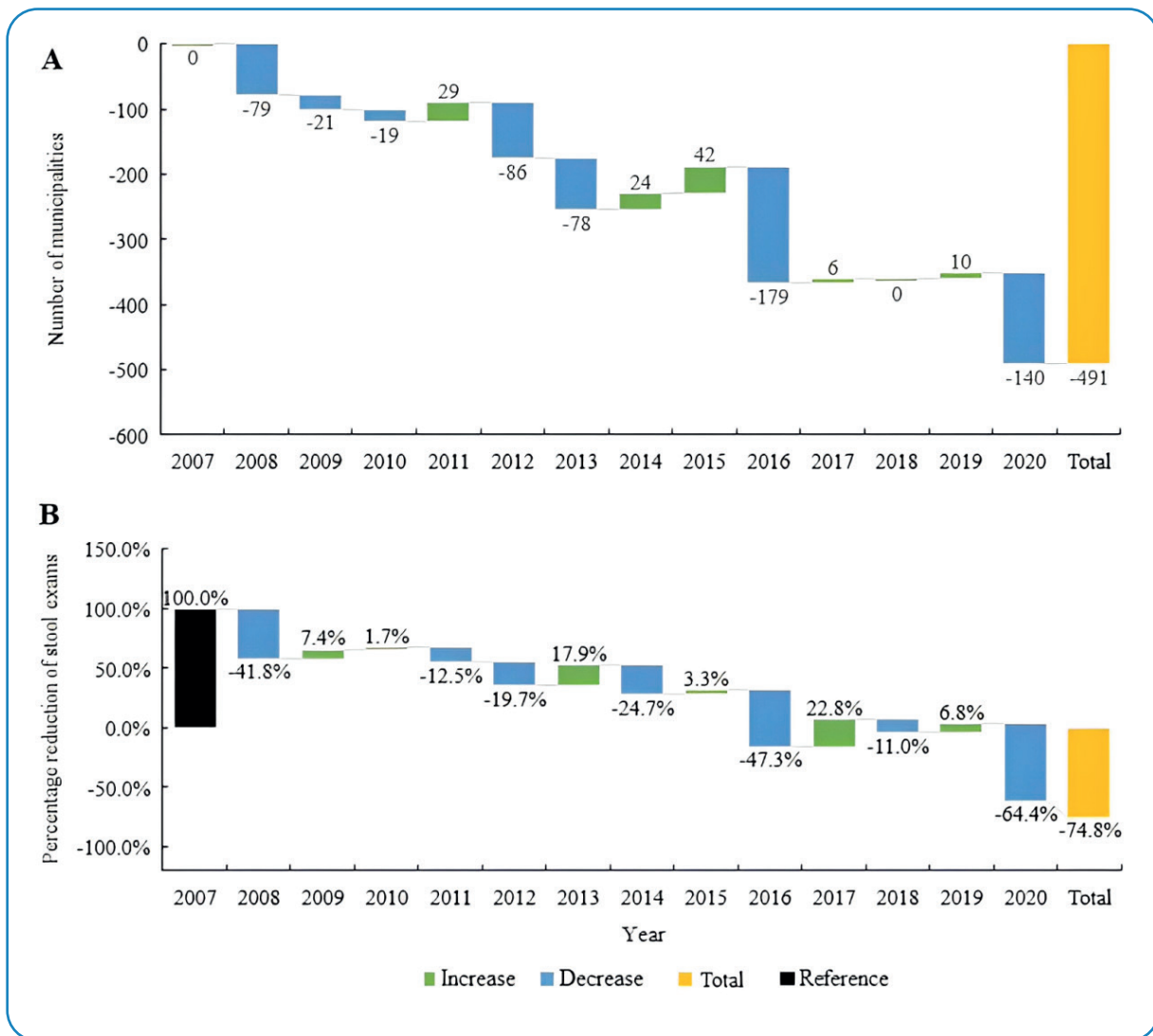
**Authors' contribution:** DTC performed the statistical analysis, prepared and writing the manuscript; FCM organized, removed the inconsistencies, and tabulated the databases, participated in the revision of the manuscript; MJE organized, removed the inconsistencies, participated in the revision of the manuscript, and provided critical comments; SMG designed and coordinated the study, revised the manuscript and provided critical comments; DSB participated in the conception and design of the study and supervised the statistical analysis; participated in the revision of the manuscript, and provided critical comments. All authors read and approved the final version of the manuscript.

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**FIGURE 1: (A)** Annual changes in the total number of municipalities with an active schistosomiasis control program, Blue bars indicate a decrease, and green bars indicate an increase compared to the previous year. **(B)** Annual percentage change in the number of stool examinations compared to the previous year. Blue bars indicate a decrease, and green bars indicate an increase.

Compared to the previous year, 2020 saw the sharpest decline in the number of stool samples examined, with a decrease of 64.4% compared to 2019. The second-largest reduction occurred in 2016, with a decrease of 47.3% (Figure 1B).

The decline mirrored a downward trend in the positivity rate for schistosomiasis among the examined population. In 2007, Brazil had a positivity rate of 5.40% (95% CI, 5.27-5.53), with roughly two million individuals examined. By 2020, the positivity rate dropped to 2.83% (95% CI, 2.75-2.93), with only 268,659 examined individuals (Supplementary Material and Figure 2).

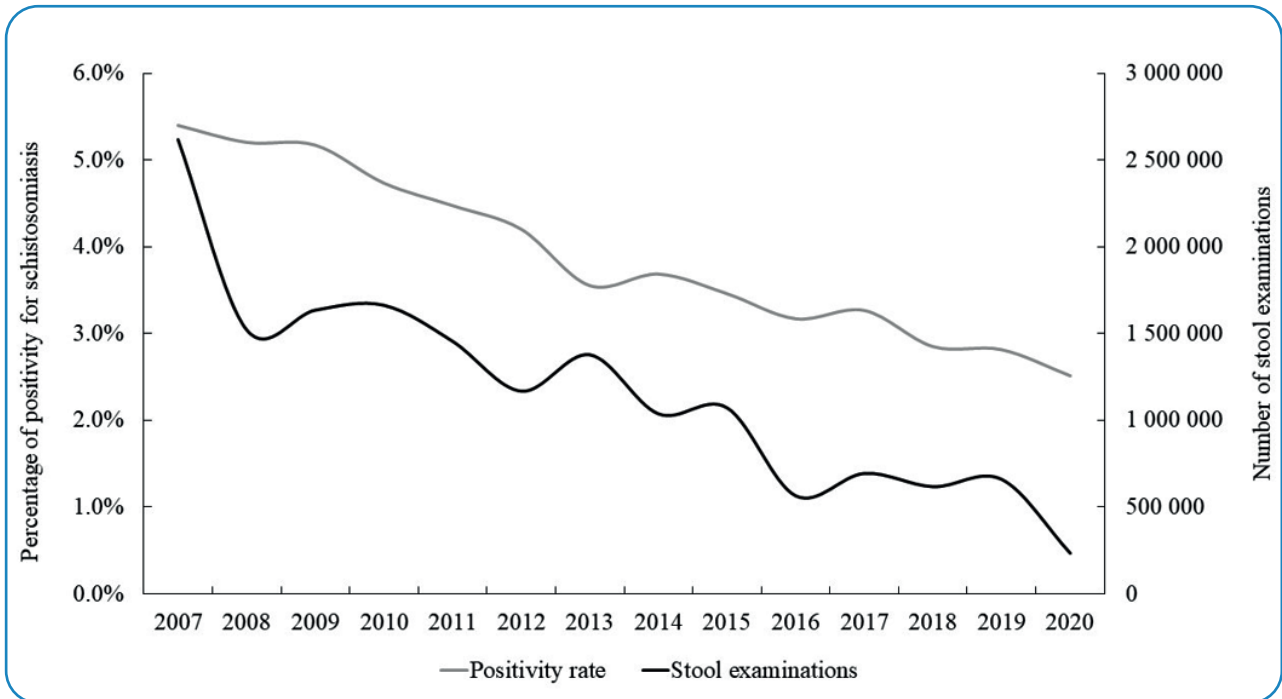
In addition to PCE data, we analyzed and compared data from the SINAN for the same period. During this timeframe, SINAN reported 155,008 cases. While the number of notified cases decreased over time, the graph (Figure 3) indicates an increase in the number of deaths. This resulted in a significant negative correlation ( $r = -0.686, p < 0.05$ ) between notified cases and deaths during the study period. This suggests a decrease in the total number of cases, but with a higher proportion resulting in death,

leading to an increase in mortality from less than 0.1% in 2007 to approximately 2.5% in 2020. Interestingly, the number of severe cases reported by SINAN remained relatively constant throughout the period, with a total of 7,697 reported cases (Figure 4).

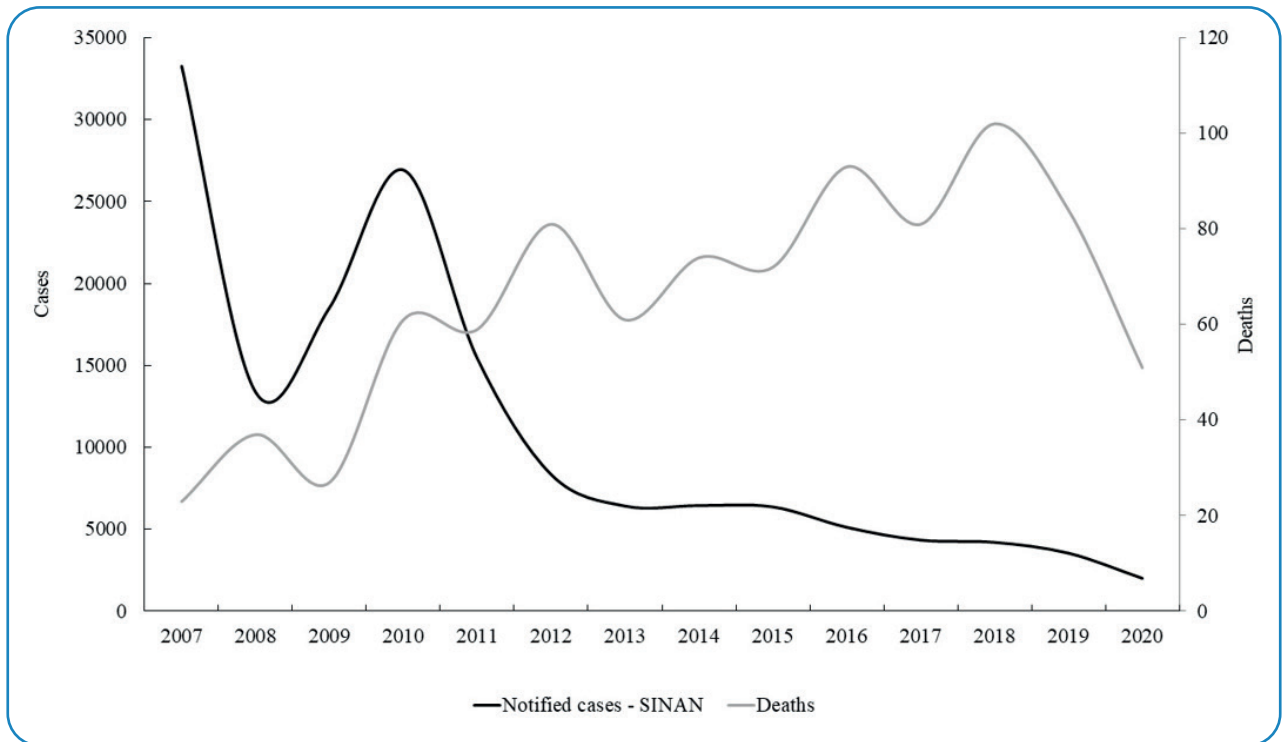
## DISCUSSION

This study examined the effects of the PCE in Brazil from 2007 to 2020. While our results show a decrease in schistosomiasis cases over time, a trend observed in both SISPCE and SINAN data, there's a concerning aspect regarding PCE performance.

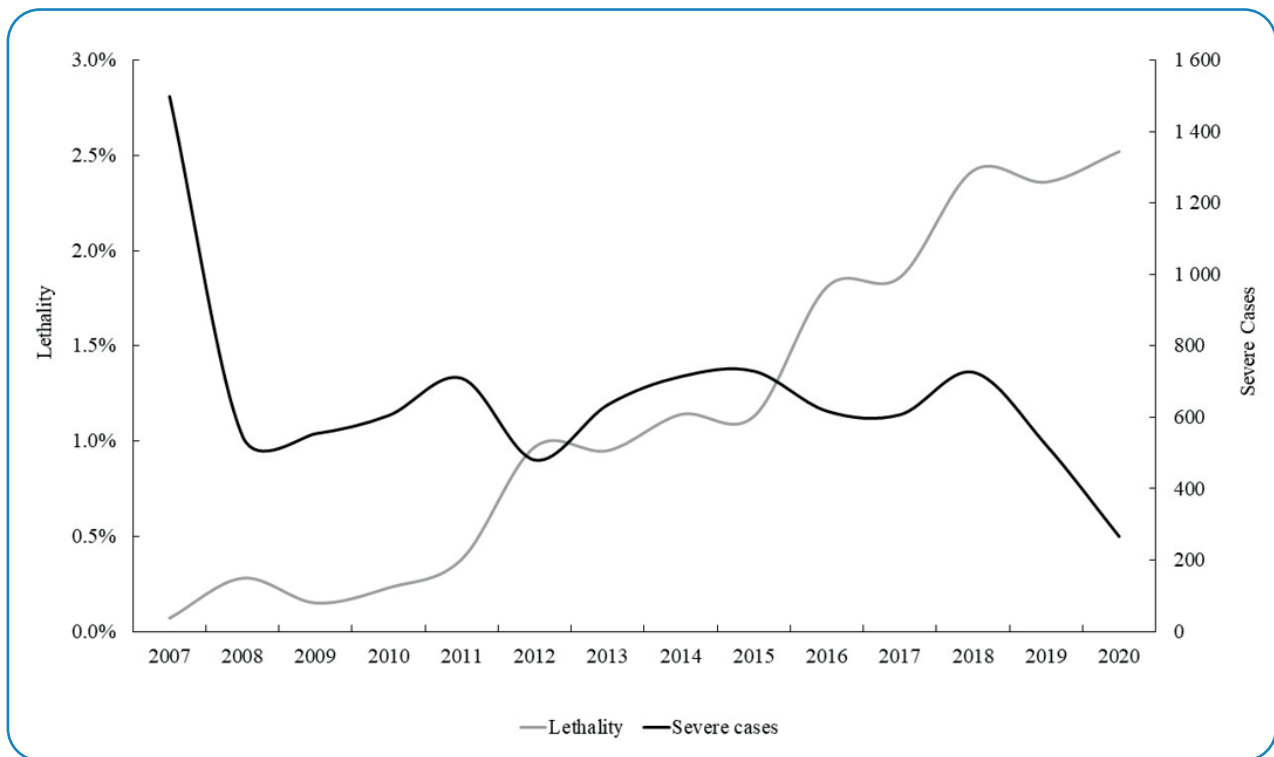
Apesar do sucesso anterior relatado do programa, no Brasil houve uma diminuição nas taxas de positividade ao longo do tempo. No entanto, isto não foi acompanhado por uma diminuição no número de casos graves, resultando num aumento de mortes. The concerted actions of the PCE managed to reducing case numbers through active case finding and treatment<sup>13</sup>, there was a decrease in PCE activity over time, as evidenced by fewer participating municipalities and stool examinations. This raises the



**FIGURE 2:** Annual positivity rate for schistosomiasis and total number of stool examinations performed annually in municipalities with an active schistosomiasis control program.



**FIGURE 3:** Annual number of notified schistosomiasis cases (black line) and deaths attributed to schistosomiasis (grey line) in Brazil (data from SINAN).



**FIGURE 4:** Annual number of severe schistosomiasis cases (black line) and lethality rate (grey line) in Brazil (data from SINAN only).

possibility that some municipalities may have discontinued their control programs. Potential reasons for program discontinuation could be twofold: i) the perception of a reduction in infection rates, thus prioritizing other health activities, and ii) errors in the notification of the disease.

The decrease in schistosomiasis positivity rate, from 5.4% in 2007 to 2.5% in 2020, suggests success for the PCE. However, this positive trend coincides with a decline in active case-finding efforts, as evidenced by the drop in stool examinations performed (from 2,620,752 in 2007 to 661,497 in 2019, a decrease exceeding 74%).

This reduction might be attributed to a few factors. Inconsistencies in notification systems exist, with discrepancies between the Schistosomiasis Surveillance and Control Program Information System (SISPCE for its initials in Portuguese) and SINAN. Additionally, some municipalities might have under-reported cases as individuals treated in primary healthcare may not consistently inform the PCE team, leading to inaccuracies. This lack of communication between teams makes it difficult to report cases accurately<sup>14</sup>.

The year 2020 saw a particularly sharp decline in stool tests, nearly 50% lower than 2019. This can likely be attributed to the impact of the coronavirus disease-2019 (COVID-19) pandemic. Many professionals were redeployed to combat the virus' spread. Furthermore, the World Health Organization recommended suspending active search activities, mass treatment campaigns, and health education initiatives for neglected tropical diseases during the pandemic's peak<sup>15</sup>. This recommendation likely contributed to the significant drop in stool examinations in 2020. However, concerns have been raised that interrupting control programs for *Schistosoma mansoni* and *S. haematobium* could lead to a resurgence of cases in the future<sup>16</sup>.

Following decades of control interventions and the implementation of the PCE, areas with low schistosomiasis endemicity have been increasingly common<sup>10,17</sup>. The Kato-Katz method remains the primary diagnostic tool used in control programs, even in these low-endemicity settings, due to its practicality and affordability<sup>18,19</sup>. However, a significant drawback of this method in these areas is its reduced sensitivity, particularly for individuals with low parasite burden<sup>20,21</sup>. Increasing the number of stool samples examined per slide can improve test sensitivity<sup>20-22</sup>.

Recent PCE data might suggest a successful program nearing eradication. However, studies using more samples or more sensitivity tests have shown a positivity rate 2.3 times higher<sup>21</sup>. Despite recommendations to increase sample numbers, technical guidelines suggest increasing the number of slides examined per stool sample in low-endemicity areas<sup>8</sup>. However, resource limitations, both financial and human, often hinder the implementation of this approach, making it difficult to identify positive cases in areas with low endemicity or parasite burden<sup>21,23</sup>.

Underreporting by municipalities may be another factor contributing to the decrease in reported positive cases. Brazil utilizes two independent notification systems for schistosomiasis: SISPCE and SINAN. This dual system can lead to confusion and underreporting, potentially impacting testing, diagnosis, and notifications. Technical guidelines for schistosomiasis surveillance in Brazil recommend notifying SINAN of all diagnosed cases in non-endemic areas, regardless of severity. Conversely, in endemic areas, only severe clinical forms should be reported to SINAN, with other cases reported to SISPCE<sup>8</sup>. Additionally, operational data from coproscopical, epidemiological, and malacological surveys are also included in SISPCE reports<sup>8</sup>.

Rondônia is not endemic for schistosomiasis. Despite historical records suggesting its potential endemicity since the 1980s<sup>24</sup>,



active PCE programs successfully controlled the decrease until 2008. At that point, the program was discontinued due to the presumed eradication of transmission within the state. However, reported outbreaks were not caused by local transmission but rather by infected individuals migrating from highly endemic states in southeastern or northeastern Brazil<sup>25</sup>. This migration risk extends beyond Rondônia, as evidenced by reports of focal transmission in Rio Grande do Sul<sup>26</sup>. These cases highlight the importance of continuous schistosomiasis monitoring. The absence of schistosomiasis data for São Paulo can be explained by their independent PCE notification system. This utilized its system to track program activities, rendering data incompatible with the national system<sup>8</sup>.

The observed negative correlation between deaths and reported cases suggests a potential consequence of reduced PCE activity. Ideally, trends in severe cases and deaths would mirror trends in reported cases; however, this was not the case in this study. The rise in lethality and continued persistence of severe cases might indicate delayed diagnosis. This, as reported elsewhere, could lead to worsening clinical situations for patients and an increased risk of death during chronic infection<sup>16,27</sup>. Additionally, these more severe cases could place a significant burden on the healthcare system due to increased public spending on treatment and patient follow-up.

While data shows a decline in schistosomiasis-positive cases and positivity rates over time, the number of severe cases remained relatively constant between 2008 and 2018, exceeding 500 cases annually. This suggests a potential underdiagnosis of asymptomatic cases or a lack of proper case management. The decrease in severe cases observed in 2019 and 2020 could be attributed to several factors, including the COVID-19 pandemic, competing healthcare priorities, or delays in reporting<sup>16</sup>.

Furthermore, the suspected decline in PCE activity in many municipalities is corroborated by the observed increase in deaths and lethality during the study period. This trend coincides with a strong negative correlation between reported positive cases and deaths in the SINAN data.

While schistosomiasis is chronic with a slow progression, the leading causes of death are often related to severe clinical forms like liver cirrhosis, portal hypertension, colitis, pulmonary complications, and neurological issues. These conditions typically develop decades after the initial infection<sup>25,28</sup>. The observed rise in lethality, coupled with the negative correlation between lethality and reported cases, suggests potential underreporting or misdiagnosis. Both scenarios are concerning and could represent a setback in Brazil's fight against schistosomiasis.

The latest National Survey of the Prevalence of Schistosomiasis Mansoni and Soil-Transmitted Helminth Infections (2010-2015) estimated a national schistosomiasis prevalence of 0.9% in Brazil (Katz, 2018). However, this school-based survey had limited coverage in key endemic areas, particularly southeastern and northeastern regions. Additionally, the results weren't statistically adjusted to account for the reduced sensitivity of the two-slide Kato-Katz method, as documented in other studies<sup>20,21,29</sup>. This potentially misleading data might have influenced health policymakers, leading to the downplay of the schistosomiasis problem in Brazil. Consequently, control efforts and financial support for municipal interventions may have been reduced.

A false perception of nearing schistosomiasis elimination, combined with the discontinuation of control activities, could result in a resurgence of the disease in Brazil, as there are still areas with active transmission in several states of the country<sup>30,31</sup>. If control activities are not resumed, there may be a significant increase in schistosomiasis infection rates<sup>12</sup>. This has already been reported, and the situation might worsen due to the interruption of neglected tropical disease control programs during the COVID-19 pandemic<sup>27,32,33</sup>.

Schistosomiasis is a chronic, debilitating disease that imposes a significant burden on the Brazilian public health system. The recent decline in PCE activity coincides with an increase in reported schistosomiasis lethality, leading to higher in public healthcare costs<sup>34</sup>. In most endemic areas, control primarily relies on diagnosis and preventive chemotherapy for at-risk populations. Therefore, continued PCE efforts are crucial for disease control and achieving the Sustainable Development Goals outlined in the 2030 agenda<sup>35,36</sup>.

As this study relied on secondary data, limitations exist regarding data availability and utilization. Endemic areas might have issues with incomplete reporting, leading to missing or unknown schistosomiasis information. Additionally, the ecological study design prevents us from establishing causal relationships. Despite these limitations, the data provided statistically significant insights. It revealed a concerning decline in PCE activity, jeopardizing Brazil's goal of eliminating schistosomiasis as a public health issue by 2030<sup>35</sup>.

This decline in PCE activity poses serious public health threats. Without the program's early diagnosis efforts, the number of severe cases increases, leading to higher healthcare system costs. The gradual decrease in control activities over the past five years has reached worrying levels. It hinders early diagnosis, potentially leading to an expansion of endemic areas, a rise in severe cases, and a significant financial burden on the health sector.

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