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A general and epidemiological overview of strongyloidiasis in Brazil

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Abstract

Strongyloidiasis, caused by *Strongyloides stercoralis*, is a neglected parasitic disease and a major global public health issue. This infection exhibits diverse clinical manifestations that, along with the high rates of asymptomatic cases and low-sensitivity diagnostic methods, contribute to the underreporting of the disease. With an estimated 600 million people infected worldwide, this disease is particularly prevalent in tropical and subtropical regions with poor sanitary conditions, which includes Brazil. Understanding the epidemiology of the disease is essential for the development of control strategies, but the lack of comprehensive data makes it difficult to identify the real impact of the infection, thus leading to underreporting and a lack of awareness of its severity on public health. Given this scenario, this literature review aimed to summarize the reported prevalence and associated factors of strongyloidiasis in Brazil. A total of 33 articles published between 2005 and 2025 were retrieved from PubMed, Science Direct, Scielo, and LiLacs databases using keywords related to strongyloidiasis in Brazil. The data collected in this review indicate that the majority of the published studies are concentrated in the Southeast region of Brazil, with the state of Minas Gerais accounting for the highest number of publications. It was also observed that the prevalence of strongyloidiasis is underestimated due to diagnostic challenges and high rates of false negatives, especially among asymptomatic patients. In addition, the scarcity of specific studies on the disease in Brazil limits the understanding of its true incidence, underscoring the need for further research.

Introduction

Strongyloidiasis is a neglected parasitic disease caused by the geohelminth *Strongyloides stercoralis*, which remains a global public health issue. Despite its varied clinical manifestations, asymptomatic cases and low-sensitivity diagnostic methods contribute to high levels of underreporting (Czeresnia and Weiss 2022; Luvira *et al.* 2022).

Strongyloidiasis has a high prevalence worldwide, with an estimated 600 million infected individuals, especially those in tropical and subtropical areas exposed to poor sanitary conditions (Buonfrate *et al.* 2020; Yang *et al.* 2024). In addition to its high prevalence, the infection by *S. stercoralis* raises concerns as it can persist for long periods within the host and potentially progress to death, particularly in cases of immunosuppression (Czeresnia and Weiss 2022; Yang *et al.* 2024).

S. stercoralis has a complex life cycle. It has both free-living and parasitic phases (Page *et al.* 2018; Yeh *et al.* 2023). Infection occurs primarily through the cutaneous route, where the filariform larvae, present in the soil, penetrate the human skin and migrate through the circulation to the lungs (Czeresnia and Weiss 2022). Moreover, infection can also occur through the ingestion of filariform larvae-contaminated food and water or through anal-oral contact, enabling an autoinfection cycle that can persist for decades (Czeresnia and Weiss 2022; Luvira *et al.* 2022; Yang *et al.* 2024).

Once the *S. stercoralis* infection is established in humans, varied clinical manifestations may occur. Factors such as parasitic load and host immunity are linked to severity. The infection can be classified as acute, chronic, hyperinfection syndrome or as disseminated infection (Luvira *et al.* 2022). Larvae migration can transport microorganisms from the gastrointestinal tract to other tissues, resulting in concomitant bacterial infections (Yeh *et al.* 2023). The disseminated form of infection is associated with intravascular coagulation, aseptic meningitis, and renal and respiratory failure. Thus, a high mortality rate of 87.1% is reported, highlighting the need for strongyloidiasis control programs (Yeh *et al.* 2023).

Strongyloidiasis diagnosis consists of observing larvae in fecal samples; however, larvae elimination is intermittent and limited, especially in the chronic phase of the disease. This contributes to the low sensitivity of the fecal examination, necessitating the analysis of up to

7 fecal samples (Costa *et al.* 2021; Page, Judd and Bradbury 2018). Even so, due to its low cost, this technique remains the predominant method utilized in endemic areas, while serological and molecular methods of greater specificity and sensitivity are rarely implemented in these regions (Bosqui *et al.* 2020; Bosqui *et al.* 2021; Costa *et al.* 2021). Thus, the ability of the infection to remain clinically asymptomatic and chronically unnoticed, along with diagnosis failure, allows the accelerated reproduction of larvae, leading to their dissemination (Schär *et al.* 2013).

Treatment reduces morbidity and mortality, as well as interrupts the parasite cycle, preventing autoinfection and heteroinfection. Mass drug administration of ivermectin as a control strategy is being investigated by the World Health Organization (WHO) in endemic locations (Buonfrate *et al.* 2020; Collyer and Anderson 2024; WHO 2020a). The implementation of control measures is a determining factor strongly associated with Strongyloidiasis prevalence in different populations and regions (Gordon *et al.* 2024; Page, Judd and Bradbury 2018).

It is known that the global prevalence of the disease, however, is often underestimated due to low diagnostic sensitivity, contributing to its underreporting (Buonfrate *et al.* 2020; Luvira *et al.* 2022; Requena-Méndez *et al.* 2013). Globally, it is estimated that approximately 614 million people are infected annually by *S. stercoralis* and 2.6 billion are at risk of infection (Buonfrate *et al.* 2020; Fleitas *et al.* 2022). In tropical and subtropical regions, where humidity and high temperatures allow higher chances of survival and successful development of larval forms, between 10% and 40% of the population are affected (Vasquez-Rios *et al.* 2019).

Foci of infection occur mainly in places of poor sanitation, facilitating its transmission through fecal contamination (Schär *et al.* 2013). Due to the significant size of the affected and at-risk population and its relation to poverty and lack of adequate water and sanitation conditions, strongyloidiasis is classified as a neglected tropical disease (NTD) (WHO 2017). Despite its significant impact on public health, there are no control strategies implemented at the global level or in endemic regions. However, this scenario is expected to change with the recent inclusion of strongyloidiasis by WHO in the 2021–2030 strategic road map for the control of neglected tropical diseases (Buonfrate *et al.* 2020; WHO 2020a; WHO 2023).

Several regions of Brazil offer ideal environmental and sanitary conditions for the development and persistence of *S. stercoralis* larvae (Carmo *et al.* 2005; Schär *et al.* 2013). Thus, according to a meta-analysis on the global prevalence of *S. stercoralis*, Brazil and Thailand emerge as the main foci of strongyloidiasis with prevalence rates ranging from 10.8% to 17% and 23.7% to 34.7%, respectively (Schär *et al.* 2013).

Accurate characterization of strongyloidiasis epidemiology is the first step toward implementing disease control programs, according to WHO (2020b). However, the epidemiology of strongyloidiasis is poorly documented or completely unknown in several countries (WHO 2020b; WHO 2023). This lack of comprehensive epidemiological data results in a limited knowledge of the real public health impact of the disease, since most deaths caused by the parasite go undetected (Buonfrate *et al.* 2020). Therefore, this literature review aims to summarize reports of the prevalence and factors associated with strongyloidiasis in Brazil, a place considered a hotspot for the disease, in order to contribute to the formulation of prevention and control strategies for this parasitosis (Luvira *et al.* 2022).

Methods

Articles published between 2005 and 2025 were obtained by using the following keywords: Strongyloidiasis; Brazil; *Strongyloides stercoralis*; and Epidemiology. These terms were searched in the title and abstract fields. The databases used were PubMed, Science Direct, Scielo and LiLacs. A total of 88 scientific articles were obtained with this search, of which only 33 were retained for this study. Exclusion criteria included review articles, editorials, or other publications without primary research data, duplicated papers, and experimental studies lacking data on *S. stercoralis* (Figure 1).

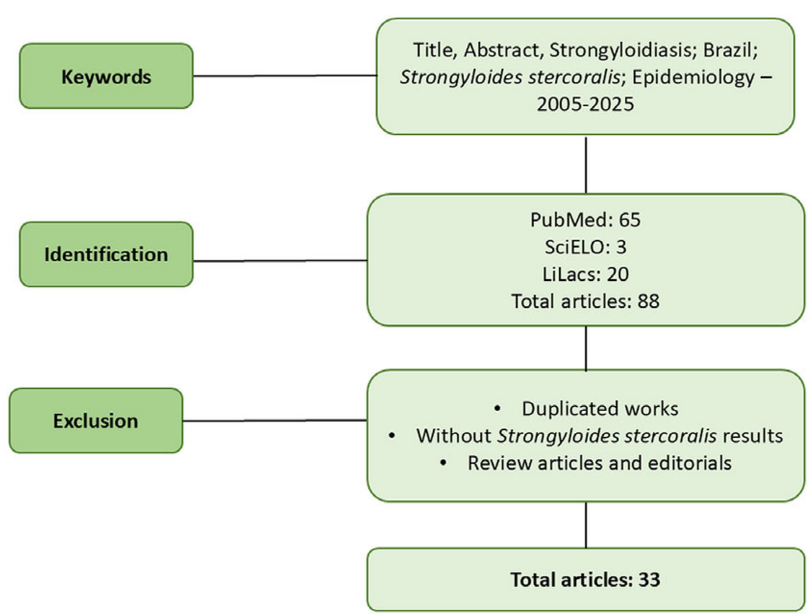

Figure 1. Flowchart of the selection process of the studies included in this review. The flowchart illustrates the stages of literature search, of screening, and of inclusion of articles, including the number of records identified in each database, the applied exclusion criteria, and the final number of studies retained.

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Results and discussion

An examination of the included articles revealed that most of the published works were concentrated in the Southeast region of the country, predominantly in the state of Minas Gerais (21.6%), which also had the highest number of publications in the country, followed by São Paulo (18.9%), Rio de Janeiro (10.8%) and Espírito Santo (2.7%). The Northeast region had the second-highest number of publications, with the state of Ceará having the largest number of published works in this region (8.1%), followed by Bahia (5.4%). In the South region, the state of Paraná had the largest number of studies (5.4%). The North and Central-West regions had the smallest number of published works, with a very similar distribution between them, both registering only 2.7% of all articles included in this review (Figure 2).

Table 1 presents the geographical regions of the retained articles, listed in decreasing order by the number of articles. The table also provides information on the positivity rate for *S. stercoralis*, the population analyzed, associated comorbidities, and the type of analysis used to obtain the results in each study.

The publications examined in this review demonstrate a wide distribution of strongyloidiasis and report considerably variable prevalence rates. However, these estimates should be interpreted with caution, as many studies are based on small sample sizes, which may compromise the reliability of the reported data. Robust prevalence estimates are still scarce in most regions due to the limited number of investigations and the use of small sample sizes. The observed variation may also be influenced by the diagnostic methods employed, the population profiles investigated, and the methodological approaches used. In Brazil, this disease is neglected and is not subject to mandatory reporting, which limits the accurate identification of at-risk populations. Additionally, the available studies usually investigate parasitic infections in general, with no specific focus or direct association with strongyloidiasis (Governo do Brasil (GOV) 2025; WHO 2023).

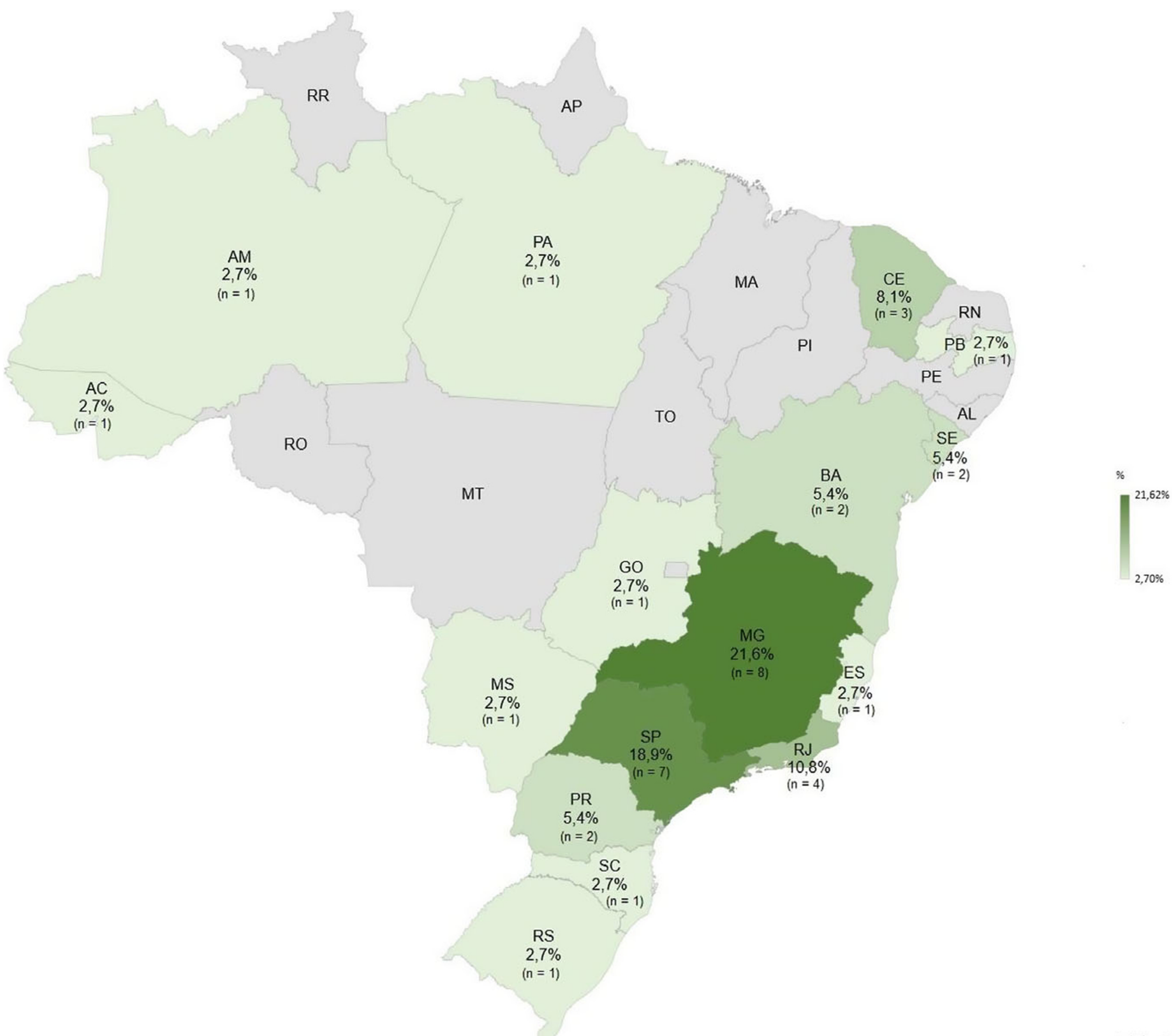

Figure 2. Geographic distribution of the number of published studies on the epidemiology of strongyloidiasis in Brazil, divided by state. The map highlights the regions with the highest number of studies according to scale on the right, represented as percentages (%). Gray areas indicate states with no studies found.

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Table 1. Summary of the studies found regarding the epidemiology of strongyloidiasis in Brazil. The data include the region and state where the study was conducted, positivity rate, population group and associated comorbidities, diagnostic method, and reference

	Study Location	Positivity Rate	Studied Population / Associated Comorbidities	Type of Analysis	Reference
SOUTHEAST	Minas Gerais	5% (*n*=10)	Institutionalized and community-dwelling elderly	Coprological	Naves and Costa-Cruz 2013
	Minas Gerais	Viçosa 1.91% (*n=8*) Muriaé 0.49% (*n=9*)	Residents of urban and rural areas	Coprological and medical records	Iasbik *et al.* 2018
	Minas Gerais	53.9% (*n=139*)	Patients treated at the Central Clinical Analysis Laboratory	Serological	Nunes *et al.* 2018
	Minas Gerais	0.8% (*n=1*)	Children and staff at two daycare centers	Coprological	Moura *et al.* 2017
	Minas Gerais	5.4% (*n=22*)	Indigenous community	Coprological	Assis *et al.* 2013
	Minas Gerais	1.3% (*n=2*)	Children from peripheral districts	Coprological	Machado *et al.* 2008
	Espírito Santo	Alcoholics 20.5% (*n*=263) Non-alcoholics 4.4% (*n*=590)	Alcoholics and non-alcoholics	Medical records	Marques *et al.* 2010
	Rio de Janeiro	0.3% (*n*=1) -	Residents of rural areas	Coprological	Barbosa *et al.* 2018
	Rio de Janeiro	4.3% (*n=32*)	Patients treated at the Evandro Chagas National Institute of Infectology	Coprological	Faria *et al.* 2017
	São Paulo, Minas Gerais and Ceará	2.4% (*n*=2)	Liver and/or kidney transplant recipients	Medical records	Batista *et al.* 2011
	São Paulo	qPCR: 32.7% (*n*=49) cPCR: 17.3% (*n*=26)	Kidney, liver, and bone marrow transplant candidates	Molecular	Paula *et al.* 2018
	São Paulo	1.16% (*n=167*)	Results of parasitological stool tests performed at the Parasitology Laboratory of Marília Medical School (FAMEMA)	Medical records	Martins *et al.* 2019
	São Paulo	0.14% (*n=1*)	HIV-infected patients on antiretroviral therapy	Stomach and duodenum mucosa biopsies	Werneck-Silva *et al.* 2009
	São Paulo	6.7% (*n=33*)	Patients treated at the Parasitology Laboratory of the Faculty of Pharmaceutical Sciences	Coprological	Miné *et al.* 2008
	São Paulo, Rio de Janeiro and Ceará	0.33% (*n=53*)	Kidney transplant recipients	Medical records	Miglioli-Galvão *et al.* 2020
	Unspecified hyperendemic region	IgG 9.2% (*n*=7)	Patients with type 2 diabetes and other metabolic diseases	Serological	Gonzaga *et al.* 2023
NORTHEAST	Bahia	4.7% (*n=10*)	Residents of rural areas	Coprological	Farias *et al.* 2023
	Bahia	Alcoholics 23.5% (*n=78*) Non-alcoholics 5.4% (*n=5*)	Alcoholics and non-alcoholics	Coprological	Silva *et al.* 2016
	Bahia	Coprological 3.4% (*n=6*) Serological 20.8% (*n=37*)	HTLV–1-infected individuals	Coprological and serological	Barreto *et al.* 2022
	Ceará	pre-HAART 30.1% (*n=145*) HAART 11% (*n=11*)	HIV/AIDS patients, pre-HAART and on HAART	Coprological	Bachur *et al.* 2008
	Sergipe	Larvae 25% (*n=5*) Eggs 20% (*n=4*)	Soil samples collected from public squares	Parasitological	Lee *et al.* 2021
	Sergipe	2010/2011 2.6% 2017/2018 0.4%	School-age children	Coprological	Oliveira *et al.* 2020
	Sergipe	2010/2011 2.6% 2017/2018 0.4%	School-age children	Coprological	Oliveira *et al.* 2020
	Paraíba	2.3% (*n=2*)	Primary school students	Coprological	Monteiro *et al.* 2018

(*Continued*)

Table 1. (*Continued*)

	Study Location	Positivity Rate	Studied Population / Associated Comorbidities	Type of Analysis	Reference
SOUTH	Paraná	Positive Coprological Exam Serum IgG 96.7% (*n*=29) Saliva IgG 6.7% (*n*=2) Serum IgA soro 76.7% (*n*=23) Saliva IgA 56.7% (*n*=17)	Residents of peripheral areas	Serological	Bosqui *et al.* 2015
	Paraná and São Paulo	37.6% (*n*=174)	Indigenous communities and their attending healthcare professionals	Serological	Santarém *et al.* 2023
	Rio Grande do Sul	4.4% (*n*=3)	Cancer patients undergoing chemotherapy treatment	Coprological	Jeske *et al.* 2018
	Santa Catarina	0.7% (*n=21*)	Parasitological exams performed at a University Hospital clinical analysis laboratory	Medical records	Bueno *et al.* 2015
NORTH	Acre	OR: 3.4	Data available from the municipality's Diagnostic Support Center	Medical records	Sinhorin *et al.* 2023
	Pará	9% (*n*=9)	HTLV–1/2-infected individuals and their uninfected relatives	Coprological	Furtado *et al.* 2013
	Amazonas	5.6% (*n*=13)	Residents of urban areas	Coprological	Valverde *et al.* 2011
CENTRAL-WEST	Goiás	3.8% (*n*=3)	HIV-positive patients	Coprological	Barcelos *et al.* 2018
	Mato Grosso do Sul	0.97% (*n=1*)	Indigenous communities	Coprological	Neres-Norberg *et al.* 2014

In regard to gender, some publications suggest a possible association between *S. stercoralis* infection and males (Bachur *et al.* 2008; Barreto *et al.* 2022; Bueno *et al.* 2015; Cabral *et al.* 2015; Faria *et al.* 2017; Naves and Costa-Cruz, 2013; Santarém *et al.* 2023; Valverde *et al.* 2011). According to these authors, adult males may be more exposed to the infective forms due to occupational or behavioral factors. In Florianópolis (SC), the infection rate was 1.1% among men and 0.3% among women (Bueno *et al.* 2015). However, such differences should be interpreted with caution, especially in studies with small sample sizes, since the statistical significance of these variations is not always clear (Bueno *et al.* 2015). Furthermore, the prevalence of *S. stercoralis* infection tends to increase with age, being more frequent among adults and the elderly. In Uberlândia (MG), a study conducted with institutionalized elderly demonstrated a prevalence rate of 5% (Naves and Costa-Cruz 2013). However, children, even in areas with high endemicity, had a lower infection rate (1.3%) (Machado *et al.* 2008). This may indicate lower environmental exposure, although this difference should also be analyzed with caution. The hypothesis of increased susceptibility with age has been proposed by some authors and may be related to cumulative exposure and immunological changes (Monteiro *et al.* 2018; Moura *et al.* 2017).

In Indigenous communities from different regions, varying *S. stercoralis* infection rates have been reported. In the South and Southeast region, particularly in the states of Paraná and São Paulo, a high seroprevalence of 37.6% was observed among the Guarani, Terena, and Kaingang ethnic groups. This high rate is possibly attributed to the lifestyle of these populations and poor sanitation conditions (Santarém *et al.* 2023). However, in Minas Gerais state, the infection was identified in a smaller proportion of the Maxakali Indigenous group (5.4%) (Assis *et al.* 2013), and the prevalence of strongyloidiasis was 0.97% among Indigenous people in the state of Mato Grosso do Sul (Barbosa *et al.* 2018). Such differences may be attributed to variations in diagnostic methods, environmental and socioeconomic factors, or study sampling. In this context, associated risk factors may include environmental habits linked to hunting and fishing, lack of water treatment and septic tanks, and vulnerable socioeconomic conditions (Valverde *et al.* 2011).

Additionally, healthcare professionals working in these regions had an even higher seroprevalence (52.4%), suggesting a potential occupational risk linked to their professional activities, as they were 1.83 times more likely to be infected than the Indigenous individuals themselves (Santarém *et al.* 2023).

S. stercoralis infection has also been investigated in transplant patients in several centers in the Southeast and Northeast regions of Brazil. Positivity among these patients varied, with studies reporting a rate of 2.4% in São Paulo, Uberlândia, and Belo Horizonte, while only 53 cases tested positive out of more than 15,000 patients analyzed in centers from Rio de Janeiro, São Paulo, and Ceará (Batista *et al.* 2011; Miglioli-Galvão *et al.* 2020). Other rates of *S. stercoralis* infection ranging from 0.11% to 10% have also been reported (Paula *et al.* 2018; Miglioli-Galvão *et al.* 2020). Although the overall incidence is low, transplant patients are more susceptible to severe forms of the disease, with high mortality rates, especially when the infection occurs in the first months after transplantation. Factors such as receiving a graft from a deceased donor, cumulative corticosteroid use, and previous bacterial infection were identified as risk factors for the severity of strongyloidiasis in this population (Miglioli-Galvão *et al.* 2020; Gryschek et al. 2023; Corral et al. 2024).

Across urban and rural areas of different states, the prevalence rate of *S. stercoralis* varied. In Bahia, a prevalence of 4.7% was recorded among residents of rural areas, while the rural region of Sumidouro (RJ) had a high rate of general intestinal parasitism

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(64.3%), but low prevalence of strongyloidiasis (0.97%). In contrast, the metropolitan region of Rio de Janeiro had positivity rates of 4.3% (Faria *et al.* 2017; Barbosa *et al.* 2018; Farias *et al.* 2023). Located in the non-metropolitan area of São Paulo state, the city of Araraquara had a positivity rate of 6.7%, higher than that of Marília (1.16%) which is also in the inland region of São Paulo (Miné *et al.* 2008; Martins *et al.* 2019). In Alfenas (MG), serological diagnostic methods revealed a high positivity of 53.9%, with higher occurrence in peripheral neighborhoods (Nunes *et al.* 2018). Several authors have linked these infection rates to inadequate sanitation conditions and direct soil contact (Barbosa *et al.* 2018; Neres-Norberg *et al.* 2014).

Studies conducted with specific groups, such as alcoholics, have also been analyzed and have demonstrated greater vulnerability of this population to infection by *S. stercoralis*. A group of alcoholics in Vitória (ES) and Salvador (BA) exhibited significantly high positivity rates of 20.5% and 23.5%, respectively. This greater susceptibility in alcoholics may be related to the fact that chronic alcoholism favors infection through multifactorial mechanisms, including malnutrition, poor hygiene, and immunosuppression. Additionally, high cortisol levels were observed in a group of infected alcoholics, suggesting a possible association with high parasite load and increased risk of hyperinfection (Marques *et al.* 2010; Silva *et al.* 2016). These findings indicate that social and occupational factors may contribute to an increased risk of exposure to *S. stercoralis* infection.

The relationship between *S. stercoralis* and immunosuppression is another important factor that has been investigated in Human Immunodeficiency Virus (HIV) and Human T-lymphotropic Virus (HTLV) carriers. In Jataí (GO), *S. stercoralis* infection was identified in 3.8% of HIV-positive patients, while in Fortaleza (CE), it reached a rate of 30.1% (Bachur *et al.* 2008; Barcelos *et al.* 2018). At the Casa da Aids reference center in São Paulo, the positivity rate was only 0.14%, possibly influenced by the use of antiretroviral therapy (HAART); in a similar manner, in Fortaleza (CE), only 11% of patients in HAART were positive, indicating that the treatment can have a protective effect against these infections (Bachur *et al.* 2008; Werneck-Silva *et al.* 2009). Patients with HTLV also presented significant infection rates, with prevalences of 3.4% in Salvador (BA) and 9% in Belém (PA), where cases of hyperinfection were observed in patients co-infected with HTLV-1, especially among those with unfavorable socioeconomic conditions (Barreto *et al.* 2022; Furtado *et al.* 2013).

The analysis of the selected studies also indicated that the diagnosis of *S. stercoralis* in Brazil is mainly based on traditional coproparasitological examinations, such as the Graham, Baermann-Moraes, Ritchie, and Hoffman techniques, often using three fecal samples. Studies that utilized serological diagnostic methods demonstrated a high prevalence of anti-*S. stercoralis* antibodies among different populations, although these findings should be approached with caution, considering potential methodological differences and limitations in study design (Barreto *et al.* 2022; Bosqui *et al.* 2015; Gonzaga *et al.* 2023; Nunes *et al.* 2018; Santarem *et al.* 2023). In the same manner, the use of molecular techniques such as PCR and qPCR exhibited greater sensitivity in parasite detection compared to parasitological methods (Paula *et al.* 2018). The literature emphasizes the need for the complementary use of parasitological, immunological, and molecular methods to achieve a more accurate and reliable diagnosis, where molecular techniques play a crucial role in confirmation due to their high sensitivity and specificity.

Regarding strongyloidiasis treatment in Brazil, regional and population-specific variations were identified. While thiabendazole was given in isolated cases in endemic areas of the Amazon (Valverde *et al.* 2011), the administration of ivermectin resulted in parasitological cure in all individuals diagnosed with strongyloidiasis (Farias *et al.* 2023). In immunocompromised patients, specifically those with HIV infection and Acquired Immunodeficiency Syndrome (AIDS), the use of antiretroviral therapy (HAART) has been shown to exert a protective effect, contributing to a reduction in the prevalence of enteric parasites, including strongyloidiasis (Barcelos *et al.* 2018; Werneck-Silva *et al.* 2009), whereas among patients undergoing kidney transplantation who developed severe *S. stercoralis* infection, the use of ivermectin, either alone or combined with albendazole, was a common practice. However, in individuals with compromised immune responses, the efficacy of anthelmintic drugs, including azoles and ivermectin, may be limited, requiring prolonged therapeutic regimens and strict monitoring. Additionally, prophylactic treatment with ivermectin is recommended for patients who initiate corticosteroid therapy and for those with positive serology or a history of exposure to strongyloidiasis (Keiser *et al.* 2004; Miglioli-Galvão *et al.* 2020).

In summary, the available data indicates that the prevalence of *S. stercoralis* in Brazil is heterogeneous and difficult to quantify precisely, given the variability of diagnostic methods and limited study sample of many publications. Although high rates have been reported among some Indigenous communities and vulnerable populations, especially in the Southeast and Northeast regions, these findings warrant cautious interpretation. Precarious socioeconomic conditions and lack of basic sanitation emerge as consistent risk factors in several populational groups, also emphasizing that the choice and sensitivity of diagnostic methods influence the results of studies, thus reinforcing the need for complementary approaches for a more accurate diagnosis. Therefore, interpretations regarding the distribution of *S. stercoralis* infection must take the reported limitations into account, avoiding extrapolations and highlighting the need for further studies with more comprehensive data.

Conclusion

The data compiled in this review suggest that the prevalence of strongyloidiasis is probably underestimated in the literature, considering the limitations of available diagnostic methods and high rates of false-negative results, especially in asymptomatic patients. Thus, the analysis of multiple samples can contribute to a more precise diagnosis. Moreover, the scarcity of studies focused exclusively on this disease also poses a challenge to an accurate estimative of its real magnitude in Brazil. It was observed that Southeast and Northeast regions concentrated the majority of publications, with particular emphasis on the Minas Gerais state for the highest number of published works. Overall, the findings of this review underscore the need of expanding scientific research on strongyloidiasis in the country, as a crucial step toward furthering the knowledge of its distribution and strengthening its recognition as a neglected disease.

Competing interests. The authors declare none.

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