

ORIGINAL ARTICLE

KNOWLEDGE OF CHAGAS DISEASE AMONG STUDENTS OF THE BASIC EDUCATION NETWORK IN THE MUNICIPALITY OF ZÉ DOCA, MARANHÃO, BRAZIL

Alania Frank Mendonça¹, Ana Carla Silva Jansen¹, Igor da Cruz Pinheiro², Deborah Thayanne Lima de Almeida³, Jackson Ronie Sá-Silva³; Juliana Maria Trindade Bezerra^{1,4,5} and Jaqueline Diniz Pinho^{2,6}

ABSTRACT

Chagas disease (CD) is a neglected tropical disease that affects thousands of people every year. The aim of this study was to implement educational interventions on CD in schools of the municipality of Zé Doca, Maranhão, and to analyze the knowledge of the students after the educational intervention. It is a descriptive, exploratory, cross-sectional study with a quantitative approach. The participants were students regularly enrolled at the *Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão* (IEMA) and the *Centro de Ensino Professor Francisco de Assis Amorim*. Educational activities were carried out, followed by the application of a semi-structured questionnaire to assess the students' knowledge of the basic aspects of CD. A total of 114 students participated, with an average age of 16.2 years; 63.1% were female, 64.9% self-identified as mixed race, and 36.8% reported a family income below the minimum wage. In terms of housing conditions, 94.7% reported living in brick houses with plastered walls, and 64.9% reported consuming filtered water. In addition, 64.9% reported being unaware of CD; 78.0% of participants identified the parasite; 85.8% recognized the main modes of transmission routes of CD; 86.8% identified prevention methods; and 91.2% had never participated in CD awareness campaigns. Students highlighted as positive aspects the ease of understanding (44.7%), learning new information (34.2%), and the importance of the topic (21.0%). The findings suggest that students absorbed the information provided during the educational activities. Therefore, social media, combined with face-to-face health education initiatives, are essential strategies for disseminating information and contributing to the prevention of CD.

KEY WORDS: Chagas disease; health education; neglected tropical diseases.

1. Universidade Estadual do Maranhão, Programa de Pós-Graduação em Ciência Animal, São Luís, Maranhão, Brazil.

2. Universidade Estadual do Maranhão, Campus Zé Doca, Zé Doca, Maranhão, Brazil.

3. Universidade Estadual do Maranhão, Departamento de Biologia (DBIO-UEMA), São Luís, MA, Brazil.

4. Universidade Estadual do Maranhão, Campus Caxias, Caxias, Maranhão, Brazil.

5. Universidade Federal de Minas Gerais, Departamento de Parasitologia, Instituto de Ciências Biológicas, Belo Horizonte, Minas Gerais, Brazil.

6. Universidade Estadual do Maranhão, Programa de Pós-Graduação em Saúde da Família, Caxias, Maranhão, Brazil.

Alania Frank Mendonça ORCID: <https://orcid.org/0000-0002-2081-8710>; Ana Carla Silva Jansen ORCID: <https://orcid.org/0000-0002-8219-0957>; Igor da Cruz Pinheiro ORCID: <https://orcid.org/0009-0002-1450-8043>; Deborah Thayanne Lima de Almeida ORCID: <https://orcid.org/0009-0007-9153-8162>; Jackson Ronie Sá-Silva ORCID: <https://orcid.org/0000-0001-9607-3674>; Juliana Maria Trindade Bezerra ORCID: <https://orcid.org/0000-0001-9840-6217>; Jaqueline Diniz Pinho ORCID: <https://orcid.org/0000-0002-2543-4257>.

Corresponding author: Jaqueline Diniz Pinho. E-mail: jackdpinho@gmail.com

Received for publication: 4/2/2025. Reviewed: 22/4/2025. Accepted: 17/6/2025.

INTRODUCTION

Chagas disease (CD) is one of a group of neglected tropical diseases identified by the World Health Organization (WHO) and the Brazilian Ministry of Health (*Ministério da Saúde*, MS), which affect thousands of people each year, mainly economically disadvantaged populations (WHO, 2024). CD is an anthroponozoonosis caused by the protozoan *Trypanosoma cruzi* (Chagas, 1909), which, from its discovery to the present day, remains a major public health challenge in several Latin American countries, including Brazil (Pérez-Molina & Molina, 2018).

There are several forms of transmission of CD, but this parasitosis is mainly transmitted by triatomines, popularly known as “kissing bugs”, which are blood-feeding insects. During or immediately after feeding, these insects tend to defecate on the skin of the individual, releasing a large amount of feces contaminated with the protozoan *T. cruzi*, which can enter the organism through the wound caused by the triatomine bite (Lima et al., 2019; Hochberg & Montgomery, 2023). It is important to emphasize that only triatomines infected with this protozoan are capable of transmitting this parasitosis.

CD can be transmitted by ingesting food contaminated with *T. cruzi* (oral transmission), from mother to child during pregnancy or childbirth (vertical transmission), through blood transfusions, or via accidental exposure. Currently, oral transmission is a particular concern in Brazil, especially in the northern and north-eastern regions, as it directly contributes to the persistence of the transmission chain (Guarner, 2019; Pereira-Silva et al., 2022).

CD is a biphasic disease. The acute phase is often asymptomatic or presents with non-specific symptoms, making early diagnosis difficult. The chronic phase may remain asymptomatic for decades or progress to severe clinical manifestations, particularly cardiac and/or digestive complications (Gonzaga et al., 2023). In Brazil, reporting of acute cases is mandatory. However, important gaps in surveillance remain, such as underreporting (Brasil, 2024a).

It is estimated that at least one million people in Brazil are currently chronically infected with *T. cruzi* (Martins-Melo et al., 2016). According to data from the Notifiable Diseases Information System (SINAN), a total of 2,777 cases of acute CD (ACD) were reported between 2010 and 2020, with the north and northeast regions accounting for 87.9% of national notifications. During the same period, the State of Maranhão alone accounted for 49.4% of cases reported in the northeast (Brasil, 2022a; Brasil, 2024b).

Given this scenario, CD constitutes a significant public health issue requiring integrated approaches. Educational activities that disseminate information and knowledge about the disease to school communities are a cost-effective primary prevention strategy that can help break the transmission chain of this parasitosis. The present study, therefore, aimed to carry out educational

interventions on CD and subsequently assess the level of knowledge among students from public schools.

MATERIAL AND METHODS

Study Design and Target Population

This is a descriptive, cross-sectional study with an exploratory design and a quantitative approach, conducted from June to October 2023 in the municipality of Zé Doca, located in the State of Maranhão. The city has a territorial area of 2,140.109 km² and a population of 40,801 inhabitants in 2022. The municipality is in the northwestern region of the State, about 325 km from the capital, São Luís (IBGE, 2023). Among the municipalities of Maranhão, Zé Doca is one of those with the lowest Human Development Index (HDI), with a value of 0.59 in 2010. The municipality's education system has a Basic Education Development Index (IDEB) of 6.1 for the first years of primary education and 4.1 for the last years, as reported in 2023. In 2009, Zé Doca had 69 educational institutions and 13 health facilities (IBGE, 2023).

For this study, a convenience sampling method was used. The population comprises 114 students of both sexes, aged between 14 and 20 years, who were regularly enrolled in the 1st, 2nd, and 3rd years of high school at the *Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão* (IEMA) and the *Centro de Ensino Professor Francisco de Assis Amorim*. The sample included two first-year classes (30 students each), one second-year class (34 students), and one third-year class (20 students).

Data Sources

A field study was conducted, starting with health education activities on CD at the *Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão* (IEMA) and the *Centro de Ensino Professor Francisco de Assis Amorim*. Initial contact was made with the school administrators, who indicated which classes were available for participation. The project team then approached the students in the classroom and informed them about the study's objectives. Only those who returned a signed Free and Informed Consent (FIC) or Free and Informed Assent (FIA) form, as applicable, were included.

Data collection and educational activities were carried out by researchers affiliated with the *Universidade Estadual do Maranhão* (UEMA), including faculty members from the health sciences department and graduate students. All team members had previously received training in research ethics, questionnaire administration, and the educational strategies to be employed. The educational intervention covered key aspects of CD, such as its general

characteristics, transmission routes, diagnosis, treatment, and preventive measures. The pedagogical approach included presenting an informational banner, holding discussion circles, distributing educational folders and printed booklets, and displaying digital content such as social media posts and podcast episodes.

Following the intervention, a semi-structured, closed-ended questionnaire was administered. This focused on the symptoms, diagnosis, transmission, and prevention of CD, with the aim of assessing students' knowledge of the disease after the educational activities. A pre-intervention assessment was not conducted due to time constraints.

Data Analysis

The data obtained from the questionnaires were tabulated and analyzed using Microsoft Excel® spreadsheets. Absolute and relative frequencies were calculated and descriptively presented.

Ethical Considerations

This study included basic education students enrolled at the *Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão* (IEMA) and the *Centro de Ensino Professor Francisco de Assis Amorim*, who agreed to participate in the proposed activities. Participants over 18 years of age signed the Term of Free and Informed Consent (TFIC). For students under the age of 18, their legal guardians signed the FICF, and the students themselves signed the Free and Informed Assent Form (FIAF). The research was approved by the Research Ethics Committee under the Certificate of Appraisal for Ethical Consideration (CAAE) number 66833222.9.0000.5554, issued by the *Universidade Estadual do Maranhão*.

RESULTS

A total of 114 high school students from first-, second-, and third-year classes were interviewed, with an average age of 16.2 years. Most of the participants were female (63.1%). The largest proportion of respondents were 1st-year students, accounting for 52.6% of the sample. Of the participants, 64.9% self-identified as mixed race. The majority reported a family income below the minimum wage (36.8%). In addition, 51.7% reported living with approximately 4 to 6 people in their household. In terms of the number of rooms in their homes, 64% reported having five or more rooms. Regarding the type of housing, 94.7% reported that their houses were built with bricks and plaster. Most students (78.9%) reported that they did not work and that they devoted themselves exclusively to their studies. In addition, 64.9% of participants reported consuming filtered water (Table 1).

Table 1. Sociodemographic distribution of high school students enrolled at the Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão (IEMA) and the Centro de Ensino Professor Francisco de Assis Amorim, Zé Doca, Maranhão, Brazil, 2023.

Variables	Categories	N (%)
Age	15 years	28 (42.5)
	16 years	46 (40.3)
	17 years	29 (25.4)
	18 years	11 (9.6)
Gender	Female	72 (63.1)
	Male	42 (36.8)
Education Level	1st year of high school	60 (52.6)
	2nd year of high school	34 (29.8)
	3rd year of high school	20 (17.5)
Race	Brown	74 (64.9)
	White	26 (22.8)
	Black	13 (11.4)
	Indigenous	1 (0.8)
Household income	Less than 1 minimum wage	42 (36.8)
	1 to 3 minimum wages	32 (28.0)
	More than 3 minimum wages	5 (4.3)
	Not informed	35 (30.7)
How many people live with you?	1 to 3 people	51 (44.7)
	4 to 6 people	59 (51.7)
	Not informed	4 (3.5)
How many rooms does your residence have?	2 to 4 rooms	41 (35.9)
	5 or more rooms	73 (64.0)
What is the infrastructure of your residence?	Wood	1 (0.8)
	Adobe	2 (1.7)
	Brick with plaster	108 (94.7)
	Brick without plaster	3 (2.6)
Do you work?	Yes	24 (21.0)
	No	90 (78.9)
Do you use filtered water?	Yes	74 (64.9)
	No	40 (35.0)

N= number of respondents; %= percentage of respondents.

More than half of the study participants (64.9%) said that they had never heard of CD before the educational campaign. Students were asked if they had ever been diagnosed with CD and, if so, what symptoms they had experienced. All respondents (100.0%) stated that they had never been diagnosed with the disease and, therefore, had not experienced any symptoms. When asked about the correct method for diagnosing CD, most students reported consulting a doctor (45.6%). All participants (100%) also reported that they did not know anyone in their social circle who had been diagnosed with CD (Table 2).

Table 2. Knowledge about symptoms, diagnosis, transmission, and prevention of Chagas disease (CD) after educational interventions among high school students enrolled at the *Instituto Estadual de Educação, Ciência e Tecnologia do Maranhão* (IEMA) and the *Centro de Ensino Professor Francisco de Assis Amorim, Zé Doca, Maranhão, Brazil, 2023*.

Variables	Categories	N (%)
Have you heard about CD before the Educational Campaign?	Yes	40 (35.0)
	No	74 (64.9)
Have you ever been diagnosed with CD?	Yes	0 (0.0)
	No	114 (100.0)
	By a doctor	52 (45.6)
	By laboratory tests	48 (42.1)
What is the correct method for diagnosing CD?	By a nursing technician	3 (2.6)
	By the patient	3 (2.6)
	Don't know	7 (6.1)
Has anyone in your social circle been diagnosed with CD?	Yes	0 (0.0)
	No	114 (100.0)
	Protozoan parasite	89 (78.0)
What is the agent responsible for transmitting CD?	Virus	8 (7.0)
	Bacteria	6 (5.2)
	Don't know	11 (9.6)
	By contact with saliva droplets of an infected person	1 (0.8)
	By feces of the kissing bug, containing the causative agent, and consumption of contaminated food	97 (85.8)
How is CD transmitted?	1 (0.8)	
	By the bite of the sand fly	14 (12.2)
	Don't know	
	By using repellents	99 (86.8)
	By using antibiotics	3 (2.6)
How can CD be prevented?	By using masks	1 (0.8)
	By seeking information on the internet	2 (1.7)
	Don't know	9 (7.8)
Have you previously participated in an educational activity about CD?	Yes	10 (8.7)
	No	104 (91.2)
If you have participated in an educational activity about CD, where did it take place?	At school	10 (100.0)

CD= Chagas disease; N= number of respondents; %= percentage of respondents.

Most participants (78.0%) identified a protozoan parasite as the causative agent of CD. In addition, 85.8% stated that the primary modes of transmission of CD were through the kissing bug (*Triatominae*), which excretes feces containing the causative agent when feeding on blood, and through the consumption of food contaminated with infected kissing bug feces. In addition, 86.8% reported that the most important preventive measures against CD were the use of repellents, mosquito nets, and preventing the establishment of kissing bug colonies in the home (Table 2).

Students were also asked if they had ever participated in any educational activities about CD, and most responded negatively (91.2%). Of those who reported participating in such activities, all stated that they had taken place at school (Table 2).

When asked what they liked most about the educational activity, students highlighted the ease of understanding the information (44.7%), learning new information (34.2%), and the relevance of the topic covered (21.0%). Additionally, when asked about how they would change their behavior because of the educational activities, students indicated that they would continue to incorporate preventive measures into their routines, such as maintaining food hygiene and using repellents to reduce the risk of infection with *T. cruzi*.

DISCUSSION

CD is a major public health challenge in the State of Maranhão, as it is in other regions of Brazil. In recent years, some municipalities in Maranhão have experienced outbreaks of CD, such as Pedro do Rosário, located in the western region of the State and adjacent to the municipality of Zé Doca. Although recent records indicate that Zé Doca has not reported any cases of the disease, its proximity to Pedro do Rosário serves as a warning of potential outbreaks. This highlights the importance of implementing preventive measures against possible outbreaks in the municipality (IBGE, 2023; Brasil, 2024b).

The socio-demographic profile of the students showed an average age of 16.2 years, with the majority being female (63.1%), enrolled in the first year of high school (52.6%), self-identifying as mixed race (64.9%), and reporting a family income below the minimum wage (36.8%). The predominance of female students and those identifying as mixed race can be attributed to the higher enrolment rates of females in high school in different regions of Brazil, as well as the fact that mixed race individuals make up a significant portion of the country's demographic composition (Brasil, 2024c; IBGE, 2024).

When analyzing the socio-demographic characteristics of students, most reported living with an average of four to six people (51.7%) in houses with proper plastering (94.7%) and enough rooms to comfortably accommodate all

residents (64.0%). Adequate housing conditions are a key social determinant of health. They are essential for community well-being, as they significantly reduce the risk of transmitting various diseases, especially those related to sanitation (WHO, 2018).

More than 64.0% of respondents reported using filtered water. Water filtration is an important strategy for the prevention of parasitic diseases, as the consumption of contaminated water or food is an important transmission route for CD (Silva et al., 1968; Dias et al., 2008; Dias et al., 2018).

More than half of the students (64.9%) reported that they had never heard of CD before the educational activities. This finding is like a study conducted in the State of Goiás, located in the central-west region of Brazil, where 69.6% of participants aged 7-15 years reported never having heard of the disease (Silveira et al., 2009). These findings underscore the importance of implementing targeted interventions to raise awareness and disseminate information about CD within the community.

All students reported that they had never been diagnosed with CD at the time of the study (100%). According to a survey of the profile of CD in Brazil, the disease predominantly affects individuals older than the age group studied, with most cases diagnosed in people aged 20-64 years (Santos et al., 2020).

Regarding the correct method for diagnosing CD, 45.6% of the students stated that it would involve medical consultation, reflecting their understanding of this information. As with other diseases, the diagnosis of CD begins with a medical consultation. If CD is suspected, the doctor may order laboratory tests to confirm the diagnosis. Standard diagnostic methods include direct parasitological tests such as fresh blood tests, smear tests, and thick blood drop tests, which are typically used for diagnosing patients in the acute phase of the disease. In the chronic phase, serological tests such as the enzyme-linked immunosorbent assay (ELISA) are used (PAHO, 2020).

All respondents reported that they did not know anyone in their social circle who had been diagnosed with CD (100%). This finding contrasts with the results of a similar study conducted in the municipality of Águas Claras, Distrito Federal, central-west region of Brazil, where 51.2% of respondents reported knowing someone who had been diagnosed with CD (Santos et al., 2022).

Most respondents identified a protozoan parasite as the causative agent of CD (78%). This result shows that the students understood the causative agent of the disease, as CD is caused by *T. cruzi*, a protozoan characterized by a flagellum and a kinetoplast. Its developmental forms include amastigote, trypomastigote, and epimastigote. In the blood of vertebrates, *T. cruzi* exists in its motile trypomastigote form, while in tissues, it assumes the amastigote form. In the digestive tract of the vector, the parasite transforms into an infective form, which is excreted in the insect feces (Lima et al., 2019; Zuma et al., 2021).

Most students reported that CD is mainly transmitted by the kissing bug during its blood meal and by eating food contaminated with *T. cruzi* (85.8%). CD is mainly transmitted by the vector, which involves contact with the feces of kissing bugs infected with the protozoan. Oral transmission, by the ingestion of food contaminated with *T. cruzi* feces, also accounts for a significant proportion of acute cases of CD in Brazil. This is particularly associated with the cultural consumption of improperly sanitized sugarcane juice and açai juice (Brasil, 2024a).

Regarding preventive measures against CD, 86.8% of the students mentioned the use of repellents, mosquito nets, and avoiding the formation of kissing bug colonies in homes. These strategies, as highlighted by the students, are essential to reduce the risk of *T. cruzi* infection. Incorporating these measures into daily routines can prevent contact with the disease vector and thus transmission (Hochberg & Montgomery, 2023).

More than 90% of the students reported participating in an educational activity about CD. This finding further underscores the importance of conducting educational activities on parasitic diseases such as CD. For a control program to be successful, it is essential that the population is aware of the vectors and the diseases associated with them. Such information needs to be disseminated on an ongoing basis (Vivas et al., 2022).

Students who participated in educational activities about CD did so within the school environment. However, there is still a need for greater emphasis on this topic for this target group, with the aim of promoting care and prevention. According to the protocol of the Brazilian Ministry of Health, it is necessary to implement the School Health Program (Programa Saúde na Escola - PSE). This program aims to strengthen actions that integrate the health and education sectors to promote the integral development of students in the public primary education system (Brasil, 2022b).

During the educational activities, 44.7% of students reported appreciating the ease of understanding the information provided, 34.2% stated that they learned something new during the training, and 21.0% highlighted the importance of the information. These results underscore the value of providing clear and accessible information to the community and illustrate the essential role the course played for public school students in Zé Doca, Maranhão. The training provided new knowledge in a clear and accessible way and contributed significantly to strengthening preventive health measures in the municipality.

When asked how they would change their behavior after the educational campaigns, students reported that they would continue to incorporate preventive measures into their daily routines, such as improving food hygiene and using repellents to prevent potential *T. cruzi* infections. Proper food hygiene and the use of repellents were strategies identified by the students as measures they would implement, demonstrating a proactive and conscious approach. Maintaining food hygiene is essential to avoid contamination with

pathogens such as *T. cruzi*, thereby preventing the oral transmission of CD. Similarly, the use of repellents is a fundamental strategy to prevent the vector transmission of the disease (Brasil, 2020).

Health education campaigns are essential strategies for promoting the health of young populations, particularly in the prevention of parasitic diseases such as CD. By understanding the disease, students can protect themselves and share this knowledge with others. This emphasizes the importance of implementing intervention initiatives focused on entomological surveillance of CD in school settings, as well as the need to extend these efforts to students from other educational institutions in the municipality of Zé Doca, Maranhão. This study was limited by the inclusion of only two educational institutions and the refusal of some students to participate, which reduced the total number of participants and consequently the final sample size.

Most of the participants understood the information provided during the educational activities and acquired knowledge about the basic aspects of CD. This demonstrates that social media, combined with face-to-face health education activities, are valuable pedagogical tools for disseminating information about parasitic diseases such as CD within the school community. These approaches can directly contribute to disease prevention and the interruption of its transmission.

ACKNOWLEDGMENTS

Alania Frank Mendonça thanks the *Coordenação de Aperfeiçoamento de Pessoal de Nível Superior* (CAPES) for the master's scholarship granted. Juliana Maria Trindade Bezerra would like to thank the *Universidade Estadual do Maranhão* for the Senior Researcher Grant (*Chamada Interna nº 05/2023 - PPG-UEMA, Bolsa de Produtividade em Pesquisa*). The authors also express their gratitude to the *Secretaria de Educação do Governo do Estado do Maranhão* for their partnership in implementing this project.

CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest to disclose.

REFERENCES

1. Brasil. Ministério da Saúde. Secretaria de Vigilância em Saúde. *Doença de Chagas: 14 de abril. Dia Mundial*. Bol Epidemiol 51: 1-43, 2020. Available at: <http://www.saude.gov.br/boletins-epidemiologicos>. Accessed on: 8.nov.2024.
2. Brasil. Ministério da Saúde. *Situação epidemiológica: Doença de Chagas*. 2022a. Available

- at: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/d/doenca-de-chagas/situacao-epidemiologica>. Accessed on: 12.sep.2024.
3. Brasil. Ministério da Saúde. *Guia de Saúde Escolar: Doenças Negligenciadas*. 2022b. Brasília: Ministério da Saúde. Available at: https://bvsmis.saude.gov.br/bvs/publicacoes/guia_saude_escola_doencas_negligenciadas.pdf. Accessed on: 1 jul. 2024.
 4. Brasil. Ministério da Saúde. *Doença de Chagas*. Portal do Governo Brasileiro: Brasília 2024a. Available at: <https://www.gov.br/saude/pt-br/assuntos/saude-de-a-a-z/d/doenca-de-chagas>. Accessed on: 04.dec.2024.
 5. Brasil. Ministério da Saúde. *Dados de Chagas*. 2024b. Available at <http://tabnet.datasus.gov.br/cgi/tabcgi.exe?sinanet/cnv/chagasma.def>. Accessed on: 26.oct.2024.
 6. Brasil. Ministério da Educação. Instituto Nacional de Estudos e Pesquisas Educacionais Anísio Teixeira (INEP). *Saiba mais sobre o panorama das mulheres na educação básica*. 2024c. Available at: <https://www.gov.br/inep/pt-br/assuntos/noticias/censo-escolar/saiba-mais-sobre-o-panorama-das-mulheres-na-educacao-basica>. Accessed on: 30.oct.2024.
 7. Chagas C. Nova tripanozomíase humana. Estudos sobre a morfologia e o ciclo evolutivo do *Schizotrypanum cruzi* agente etiológico de nova entidade mórbida do homem. *Mem Inst Oswaldo Cruz* 2:159-218, 1909.
 8. Dias JP, Bastos C, Araújo E, Mascarenhas AV, Netto EM, Grassi F, Silva M, Tatto E, Mendonça J, Araújo RF, Shikanai-Yasuda MA, Aras R. Surto agudo de doença de Chagas associado à transmissão oral. *Rev Soc Bras Med Trop* 41: 296-300, 2008.
 9. Dias AP, Calegar D, Carvalho-Costa FA, Alencar MFL, Ignacio CF, da Silva MEC, de Moraes Neto AHA. Assessing the influence of water management and rainfall seasonality on water quality and intestinal parasitism in rural northeastern Brazil. *J Trop Med* 2018: 8159354, 2018.
 10. Gonzaga BMS, Ferreira RR, Coelho LL, Carvalho ACC, Garzoni LR, Araujo-Jorge TC. Clinical trials for Chagas disease: etiological and pathophysiological treatment. *Front Microbiol* 14: 1295017, 2023.
 11. Guarnier J. Chagas disease as an example of a reemerging parasite. *Semin Diagn Pathol* 36: 164-169, 2019.
 12. Hochberg NS, Montgomery SP. Chagas disease. *Ann Intern Med* 176: ITC17-ITC32, 2023.
 13. IBGE. Instituto Brasileiro de Geografia e Estatística. *Cidades e Estados: Zé Doca*. 2023. Available at: <https://www.ibge.gov.br/cidades-e-estados/ma/ze-doca.html>. Accessed on: 18.oct.2024.
 14. IBGE. Instituto Brasileiro de Geografia e Estatística. *Cor ou raça*. 2024. Available at: <https://educa.ibge.gov.br/jovens/conheca-o-brasil/populacao/18319-cor-ou-raca.html>. Accessed on: 2.dec.2024.
 15. Lima RS, Teixeira AB, Lima VLS. Doença de Chagas: uma atualização bibliográfica. *RBAC Rev Bras Anal Clin* 51: 103-106, 2019.
 16. Martins-Melo FR, Ramos AN, Alencar CH, Heukelbach J. Trends and spatial patterns of mortality related to neglected tropical diseases in Brazil. *Parasite Epidemiol Control* 94: 103-110, 2016.
 17. WHO. World Health Organization. *Housing impacts health: new WHO guidelines on housing and health*. 2018. Available at: <https://www.who.int/news/item/26-11-2018-housing-impacts-health-new-who-guidelines-on-housing-and-health>. Accessed on: 26.sep.2024.
 18. WHO. World Health Organization. *Chagas disease (also known as American trypanosomiasis)*. 2024. Available at: [https://www.who.int/news-room/fact-sheets/detail/chagas-disease-\(american-trypanosomiasis\)](https://www.who.int/news-room/fact-sheets/detail/chagas-disease-(american-trypanosomiasis)). Accessed on: 26.oct.2024.
 19. PAHO. Pan American Health Organization. *Síntesis de evidencia: Guía para el diagnóstico y el tratamiento de la enfermedad de Chagas*. 2020. Available at: <https://doi.org/10.26633/RPSP.2020.28>. Accessed on: 26.aug.2024.
 20. Pereira-Silva FS, de Mello MLBC, Araújo-Jorge TCA. Doença de Chagas: enfrentar a invisibilidade pela análise de histórias de vida de doenças específicas. *Ciênc Saúde Coletiva* 27:

1939-1949, 2022.

21. Pérez-Molina JA, Molina I. Chagas disease. *Lancet* 391: 82-94, 2018.
22. Santos EF, Silva ÂA, Leony LM, Freitas NEM, Daltro RT, Regis-Silva CG, Del-Rei RP, Souza WV, Ostermayer AL, Costa VM, Silva RA, Ramos AN Jr, Sousa AS, Gomes YM, Santos FLN. Acute Chagas disease in Brazil from 2001 to 2018: A nationwide spatiotemporal analysis. *PLoS Negl Trop Dis* 14: e0008445, 2020.
23. Santos AE, de Oliveira ARF, Hagström L, Hecht M, Dallago B, de Macedo PMW. Educação em saúde e a doença de Chagas: realidade de uma região no centro brasileiro. *Saúde Coletiva (Barueri)* 12: 10540-10557, 2022.
24. Silva NN, Barreto AMSB, Chagas HHJCP. Surto epidêmico de Doença de Chagas com probabilidade de contaminação oral. *Rev Inst Med Trop São Paulo* 10: 265-276, 1968.
25. Silveira AC, Rezende DF, Nogales AM, Cortez-Escalante JJ, Castro C, Macedo V. Avaliação do sistema de vigilância entomológica da doença de Chagas com participação comunitária em Mambai e Buritinópolis, Estado de Goiás. *Rev Soc Bras Med Trop* 42: 39-46, 2009.
26. Vivas ALP, Ferreira RA, Oliveira ER, Ianes IM, Barbosa SE. Avaliação do conhecimento sobre a doença de Chagas em escolares das zonas rurais e urbana de municípios endêmicos em Minas Gerais. *Physis Rev Saúde Coletiva* 32: 401-421, 2022.
27. Zuma AA, Dos Santos BE, de Souza W. Basic biology of *Trypanosoma cruzi*. *Curr Pharm Des* 27: 1671-1732, 2021.