

ORIGINAL ARTICLE

Chagas Disease in the Western Brazilian Amazon: Epidemiological Overview from 2007 to 2018

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Abstract

Introduction: Chagas disease (CD) is a disease caused by the protozoan flagellates of the Kinetoplastid order *Trypanosoma cruzi*. Approximately 8,000,000 people are infected worldwide, mainly in Latin America, causing disabilities and more than 10,000 deaths per year.

Objective: This study aimed to describe the epidemiological panorama of CD in the Western Brazilian Amazon from 2007 to 2018.

Methods: In this ecological study, secondary data regarding the confirmed cases of *T. cruzi* infection in the states of Acre, Amazonas, Rondônia, and Roraima were collected from the Single Health System Notification Information System of the Department of Informatics of the Single Health System and were analyzed. The data were used to characterize the epidemiological profile of *T. cruzi* infection and to determine the frequency of infection in Western Amazonia.

Results: A total of 184 cases of CD were reported in Western Amazonia, and the highest number of cases was reported in the states of Amazonas and Acre.

Conclusion: The epidemiological panorama of the Western Brazilian Amazon from 2007 to 2018 includes a greater number of cases of *T. cruzi* infection in men aged 20–39 years and those living in rural areas. Oral transmission was prevalent in the region during the study, and the highest number of cases was reported in the months of April and December. Epidemiological data are an important resource for understanding the dynamics of CD and the main aspects related to the health-disease process.

Keywords: Epidemiological data, Epidemiology, American trypanosomiasis.

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Authors summary

Why was this study done?

This study aimed to describe the epidemiological panorama of CD in the Western Brazilian Amazon from 2007 to 2018.

What did the researchers do and find?

In this ecological study, secondary data regarding the confirmed cases of *T. cruzi* infection in the states of Acre, Amazonas, Rondônia, and Roraima were collected from the Single Health System Notification Information System of the Department of Informatics of the Single Health System and were analyzed

What do these findings mean?

A total of 184 cases of CD were reported in Western Amazonia, and the highest number of cases was reported in the states of Amazonas and Acre. The epidemiological panorama of the Western Brazilian Amazon from 2007 to 2018 includes a greater number of cases of *T. cruzi* infection in men aged 20–39 years and those living in rural areas. Oral transmission was prevalent in the region during the study, and the highest number of cases was reported in the months of April and December. Epidemiological data are an important resource for understanding the dynamics of CD and the main aspects related to the health-disease process.

INTRODUCTION

Chagas disease (CD) is a disease caused by the protozoan flagellate of the Kinetoplastid order *Trypanosoma cruzi*, whose vector is an insect belonging to the Reduviidae family and subfamily *Triatominae* popularly known as barber¹.

The most common method of *T. cruzi* transmission reported by several previous studies is through the vector; unlike other vector-borne diseases, the transmission of *T. cruzi* does not occur by inoculation of the parasite with the vector's saliva, but by exposure to feces or urine containing the infectious forms^{1,2}. Other forms of disease transmission include transplacental, blood transfusion, organ transplantation, ingestion of contaminated food, and laboratory accidents³ the possibility of contamination by consumption of contaminated game meat⁴ and sexual intercourse⁵ be ignored as well.

Eight million people are infected with *T. cruzi* worldwide, mainly in Latin America, causing disabilities and more than 10, 000 deaths per year⁶. In addition, CD has been increasingly detected in non-endemic countries because of human migration⁶.

After more than a hundred years of discovery, trypanosomiasis remains a social and public health problem in Latin America and is considered as an “invisible giant,” mainly because of the latency period that the disease can present and because it is difficult to treat during the chronic phase, causing serious injuries to vital organs⁷. It is also considered a neglected tropical

disease as only a few investments were made to study this condition and produce the necessary drugs^{7,8}, in addition to affecting the poorest population⁸.

In 2016, Brazil reported a DALY rate (indicator of days of life lost or poorly lived) of 64.7% due to CD, noting that the regions, which previously recorded the lowest number of DALYs, had an increase between 1990 and 2016, including the northern region of the country, where oral transmission CD is prevalent⁹.

In the Brazilian Amazon, increasing outbreaks of the disease have been reported in the last 10 years¹⁰, mainly due to the consumption of contaminated food, generating concern among public health managers. It is necessary to understand the epidemiology of this disease in the region; hence, this study aimed to describe the epidemiological panorama of CD in the Western Brazilian Amazon from 2007 to 2018.

METHODS

Study Design

This ecological study was conducted to examine the confirmed cases of acute CD in Western Amazonia.

Study Location and Period

The data extracted were from the four states of Western Amazonia: Acre (AC), Amazonas (AM), Roraima (RR) and Rondônia (RO), as shown in figure 1.

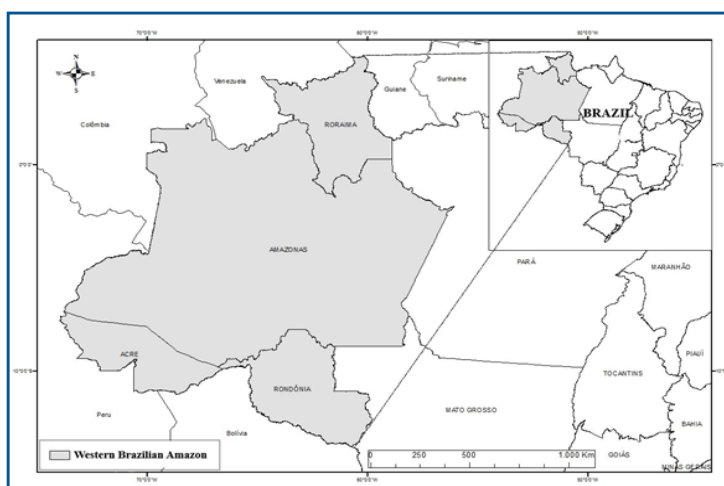


Figure1: Map of the Western Brazilian Amazon

Study Population and Eligibility Criteria

Positive cases of acute CD, reported in the period from 2007 to 2018, were included in the study. The following variables were analyzed: gender, age group, form of contagion (oral, vector, accidental, and others), seasonality, and area (rural, urban, or peri-urban). By contrast, cases reported outside the survey period were excluded.

Data Collection

In this study, we collected the secondary data from the Single Health System Notification Information System (SINAN)¹¹ of the Department of Informatics of the Single Health System and the Brazilian Institute of Geography and Statistics (IBGE)¹². These data were used to determine the population number and frequency of infection, and to characterize the epidemiological profile of people infected with *T. cruzi*.

Data Analysis

Frequency rates were calculated (number of cases/population of the locality in the year surveyed per 100,000 inhabitants).

Ethical and Legal Aspects of the Research

Approval from the Ethics Committee was not required because secondary data were used.

RESULTS

In 2007 to 2018, 184 confirmed cases of acute CD were reported in Western Amazonia. The cases registered in the states of Amazonas and Acre together represent more than 90% of the notifications in the period, in the entire region included in the study (table 1).

A higher incidence of the disease was observed in men and in those aged 20–39 years. Approximately 56% of the notifications reported in this study were due to oral infection; the months of December and April had the highest number of reported cases. A higher number of people with CD was also observed to be living in rural areas (table 2).

Table 1: Distribution of the number of cases of CD in the western amazon, from 2007 to 2018

Year	AC	Pop.	Cf.	AM	Pop.	Cf.	RO	Pop.	Cf.	RR	Pop.	Cf.	Total
2007	0	655385	0.00	28	3221939	0.87	0	1453756	0.00	0	395725	0.00	28
2008	0	680075	0.00	0	3341094	0.00	0	1493565	0.00	0	412783	0.00	0
2009	1	691132	0.14	16	3393369	0.47	0	1503928	0.00	0	421499	0.00	17
2010	5	733559	0.68	23	3483985	0.66	1	1562409	0.06	0	450479	0.00	29
2011	0	746386	0.00	0	3538387	0.00	1	1576455	0.06	0	460165	0.00	1
2012	0	758786	0.00	6	3590985	0.17	0	1590011	0.00	1	469524	0.21	7
2013	1	776463	0.13	5	3807921	0.13	0	1728214	0.00	0	488072	0.00	6
2014	2	790101	0.25	19	3873743	0.49	1	1748531	0.06	0	496936	0.00	22
2015	6	803513	0.75	10	3938336	0.25	0	1768204	0.00	2	505665	0.40	18
2016	16	816687	1.96	3	4001667	0.07	0	1787279	0.00	0	514229	0.00	19
2017	2	829619	0.24	13	4063614	0.32	0	1805788	0.00	0	522636	0.00	15
2018	7	869265	0.81	13	4080611	0.32	1	1757589	0.06	1	576568	0.17	22
Total	40 (22%)			136 (74%)			4 (2%)			4 (2%)			184 (100%)

Subtitle: AC: Acre. AM: Amazonas. RO: Rondônia. RR: Roraima. Pop.: Population according to IBGE data. Cf. Frequency coefficient. Source: Chagas Disease (DATASUS). 2020.

Table 2: Notification of acute Chagas disease in the Brazilian Western Amazon, from 2007 to 2018, according to gender, age group, form of transmission, seasonality and zone.

Variables	AC	%	AM	%	RO	%	RR	%	Total	%
Gender										
Men	25	62%	85	62%	4	100%	2	50%	116	63%
Women	15	38%	51	38%	0	-	2	50%	68	37%
Age group										
<1	3	7.5%	5	3.7%	-	-	-	-	8	4.3%
1-4	5	12.5%	8	5.9%	-	-	1	25%	14	7.6%
5-9	5	12.5%	7	5.1%	-	-	-	-	12	6.5%
10-14	3	7.5%	9	6.6%	-	-	1	25%	13	7.1%
15-19	4	10.0%	17	12%	1	25%	-	-	22	12.0%
20-39	16	40.0%	46	33.8%	2	50%	1	25%	65	35.3%

Continuation - Table 2: Notification of acute Chagas disease in the Brazilian Western Amazon, from 2007 to 2018, according to gender, age group, form of transmission, seasonality and zone.

Variables	AC	%	AM	%	RO	%	RR	%	Total	%
40-59	3	7.5%	31	22.7%	1	25%	1	25%	36	19.6%
60-64	1	2.5%	5	3.6%	-	-	-	-	6	3.3%
65-69	-	-	3	2.2%	-	-	-	-	3	1.6%
70-79	-	-	3	2.2%	-	-	-	-	3	1.6%
80- e +	-	-	2	2.2%	-	-	-	-	2	1.1%
Forms of transmission										
Orally	8	20%	94	69%	1	25%	1	25%	104	56%
Vector	30	75%	23	17%	3	75%	1	25%	57	31%
Accidental	-	-	1	0.7%	-	-	-	-	1	0.5%
Vertical	-	-	1	0.7%	-	-	-	-	1	0.5%
Ignored	2	5%	17	13%	-	-	2	50%	21	12%
Seasonality										
Jan	3	7.5%	13	10%	-	-	1	25%	17	9.2%
Feb	2	5.0%	7	5%	1	25%	-	-	10	5.4%
Mar	0	0.0%	6	4%	-	-	-	-	6	3.3%
Apr	1	2.5%	31	23%	-	-	-	-	32	17.4%
May	2	5.0%	2	1%	-	-	-	-	4	2.2%
June	11	27.5%	4	3%	-	-	-	-	15	8.2%
Jul	6	15.0%	9	7%	-	-	2	50%	17	9.2%
Aug	-	-	3	2%	-	-	-	-	3	1.6%
Sept	4	10.0%	4	3%	-	-	-	-	8	4.3%
Oct	7	17.5%	5	4%	1	25%	-	-	13	7.1%
Nov	3	7.5%	4	3%	1	25%	1	25%	9	4.9%
Dec	1	2.5%	48	35%	1	25%	-	-	50	27.2%
Zones										
Rural	36	90%	91	67%	3	75%	2	50%	132	72%
Urban	3	8%	5	4%	1	25%	2	50%	11	6%
Peri-urban	1	3%	40	29%	0	-	0	-	41	22%
Total	40	22%	136	74%	4	2%	4	2%	184	100%

DISCUSSION

Studies based on the frequency in which trypanosomiasis occurs at the regional level, detecting possible endemic areas, together with some sociodemographic factors, can serve as a basis to establish important epidemiological parameters, especially in states where CD is not endemic.

In this study, CD was predominant in men, and this may be related to the participant's work activities, such as extraction of açai and piassava; these activities increase the men's exposure to the vector and consequently to CD. In similar surveys conducted in the states of Pará¹³ and Acre¹⁴, the highest frequency was also reported in men; this finding is not consistent with the results of another survey conducted in Amazonas, which reported that women had higher exposure to CD¹⁵. This higher occurrence in men may be related to their work activities, such as extraction of natural products, which increases the possibility of contact with the disease vector.

The age group that is most frequently affected in this study corroborates with that in other studies. This finding indicates that the risk of CD infection increases during the most productive age of the individual and in those living in rural areas; during this period, the individual's most common activities were plant extraction and farming^{15,16}.

Results of other studies conducted in the same geographical region corroborate with those of our study, which reported a higher rate of infection in rural areas. This finding is because of the populations' higher consumption of açai and the processing of this fruit without following proper sanitary procedures, thus increasing the possibility of outbreaks by oral transmission^{10,14}.

Although CD in the Western Amazon region is still more prevalent in the rural areas, data from the World Health Organization⁶ showed that changes in the epidemiological profile of the disease due to rural exodus, deforestation, and urbanization have made CD a more urban and peri-urban phenomenon⁶; this has been

observed in this study, where an increase in notifications has been noted in the peri-urban areas. In a recent study, an increase in CD in the peri-urban area was observed in Venezuela¹⁷. Souza-Júnior *et al.* (2017) also observed a higher incidence of CD in an urban area in the municipality of Barcarena, Pará.

Increase in CD outbreaks due to oral transmission in the Amazon region, possibly caused by the consumption of agro-extractivist forest products without proper sanitary regulation, was pointed out as the primary reason for changing the traditional view of the Amazon as a region free of CD and acute CD¹⁸. Oral transmission is considered as a neglected transmission route¹⁹ consumption of açai (*Euterpe oleraceae*) being indicated as the primary food involved in the transmission of this disease¹⁰.

Transmission through vectors found in the study population's residences has not yet been registered in the region of Western Brazilian Amazon, although transmission by vectors that opportunely invade the houses²⁰. However, these vector-borne transmission records made available by SINAN suggest the need for an in-depth epidemiological investigation, since 31% of transmissions were registered vector-borne in a region in Roraima where there is only evidence of triatomine domiciliation²¹.

Although vector-borne transmissions by wild triatomine can possibly occur, either through direct contact with forest areas or by intrusion of these insects in an individual's home, it is possible that the data reported as vector-borne transmission have not been adequately investigated to prove this form of transmission²².

Another important factor reported in this study is that CD was more prevalent during December and April, and this finding is similar to that in another study conducted in the state of Amazonas in a different period¹⁵. Meanwhile, Oliveira *et al.* (2018) observed greater seasonality of CD in the month of June, possibly because the outbreaks that occurred in the region during that period were due to an oral transmission. Souza- Júnior *et al.* (2017) observed a higher occurrence of CD during the months with higher temperatures, suggesting that this condition favors deforestation and burning.

Hence, further studies should be conducted to evaluate the factors that interfere with the seasonality of the disease; however, the seasonal difference between the states may also be attributed to the wide harvest period of açai in the Amazon region. This period of fruit productivity coincides with the period of greater rainfall, from December to May²³. Outbreaks occurring outside this period and by oral transmission can be explained mainly by the storage of the crop products, which are available for consumption even beyond the harvest season.

Thus, in Western Amazon, *T. cruzi* infection may occur throughout the year, mainly because of the large consumption of açai and fruits of other palm trees. The risk of oral transmission through ingestion of products from palm trees was confirmed in a previous study, in which the *T. cruzi* DNA was detected in 10% of the açai pulp sold in Pará and Rio de Janeiro²⁴. This fact brings a warning and reinforces the hypothesis on the year-round risk of *T. cruzi* infection, active in the fat of açai pulps

that are frozen for prolonged periods¹⁰; thus, the products stored during the harvest may transmit the parasite even if they are consumed beyond this period.

The state of Amazonas, with the highest number of CD notifications in Western Amazonia, has already been reported in other epidemiological studies that also point to the high prevalence of acute infection and attribute the first autochthonous cases of the disease to the extraction of piassava^{15,25}. However, if the frequency coefficients are considered, Acre can also be considered as a state of great epidemiological importance; it has the highest number of people affected by the disease compared with Amazonas.

Acre had a considerable increase in disease notifications from 2016 onward. This fact was confirmed by Oliveira *et al.* (2018), who observed an increase of 316.7% in cases of CD compared with that in the previous year, which was the period in which the outbreaks that occurred in the state were due to oral transmission. Data provided by the State Epidemiological Surveillance in 2019 point to another outbreak of CD involving 15 people in the state, which further increases this coefficient.

The states of Acre and Amazonas presented frequency coefficients above the national coefficient; the data from the Ministry of Health showed that the average annual incidence of CD throughout the country is 0.061 cases per 100,000 inhabitants, with the northern region responsible for 91% of the notifications²⁶. However, these coefficients were lower than those reported in Pará, with the highest prevalence of CD in the country and located in the northern region¹¹.

Rondônia, with five cases of acute CD, corresponds to 2% of the total notifications presented in this study.

The low prevalence of CD in Rondônia may be related to the economic activities, according to the IBGE data, farming activities were more common in this state than extractive activities. Moreover, Rondônia is one of the smallest producers of açai in Western Amazonia and has the largest cattle herd in the region¹².

Carvalho *et al.*²⁷ observed a low invasion of triatomine in homes and a pattern of rural properties in Monte Negro, Rondônia, which do not favor the domiciliation of triatomine. In this municipality, the houses are mostly made of concrete and roofs are made of tiles, including henhouses and other deposits; in the same study, a large amount of triatomine were found in *Orbygnia speciosa* (Babaçu) palm trees, which mostly grow in pasture areas.

Other investigations have already reported the presence of *T. cruzi*-infected vectors in areas near human habitats and the infestation of these vectors in babassu. The development of this palm specie in that state suggests the presence of triatomine^{28,29}.

Research regarding the vectors in the state of Rondônia made possible the discovery of a new triatomine species (*Rhodnius montenegrensis*)³⁰ with reports of natural infection by *T. cruzi* and vector capacity³¹, further increasing the risk of CD transmission. There were also data on the state of individuals infected with *T. cruzi* from endemic areas of the country, suggesting non-autochthonous infections²⁸; moreover, the presence of vectors and reservoirs may enable the establishment of

a long-term domestic protozoan cycle, despite the low number of households infested with triatomine.

The destruction of natural ecotopes with agricultural expansion and the presence of triatomine, especially in areas close to human habitats, combined with the high rates of natural infection of these insects make the state of Rondônia an endemic area of CD, observing the presence of all links in the chain of transmission of the disease in the region²⁸.

Another state of Western Amazonia with a lower frequency of CD was Roraima. In one study, it states that Roraima is not considered as an endemic area for the disease³²; however, some factors of epidemiological importance deserve to be observed, such as the report of colonization of a *Triatoma maculata* species in an urban home in the state capital²¹ and the identification of new vector species in the state³³ besides the intense migratory relationship of the state with other endemic areas of the country and the neighboring country, Venezuela¹⁷.

An epidemiological study conducted in agricultural settlements in the state of Roraima detected the presence of triatomine near human habitats and animal shelters, demonstrating the potential for domiciliation of existing populations²¹ and consequently the establishment of domestic and peridomestic cycles of the disease. As a result, autochthonous transmission of CD in the state³⁴.

Roraima also received immigrants from Venezuela as of 2014; with this, there was a resurgence of previously eradicated diseases³⁵ and an increase in the number of cases of other infectious diseases such as malaria³⁶. This situation is worrisome, since the study reported the abandonment of the Chagas control program in the neighboring country and stated that it remains unclear whether blood banks are being traced¹⁷. Venezuela reported an increase in the transmission of CD, and the severe shortage of medications, due to the crisis faced by the country, has forced patients to seek medical care and treatment in neighboring countries¹⁷ including Brazil, particularly in the state of Roraima.

The lack of vaccine for CD and low investment in drug production³⁷ indicate that the focus of management is still vector control and interference in the disease cycle, justifying the need for constant surveillance of epidemiological factors favorable to the emergence of infections.

These data are important, since these states are located in the same geographic region and share several cultural aspects, besides migration. The transmission dynamics in the Amazon as a whole follows a similar pattern, demonstrating that the entire region is exposed to CD.

CONCLUSION

The epidemiological picture of CD in Western Amazonia from 2007 to 2018 corresponded to the notification of a total of 184 cases of the disease, with 2010 having the highest number of records. The epidemiological survey identified the highest occurrence

in men, individuals aged 20 to 39 years, and those living in rural areas. The main route of transmission is oral, and CD commonly occurs in the months of April and December, coinciding with the rainy periods and therefore the harvest of fruits like açai.

The description of the epidemiological panorama of CD is important to perceive the changes that have occurred over time and to identify the determining factors in the health-disease process. In addition, an efficient data recording system is required to ensure effective surveillance and to monitor the transmission dynamics in different environments in the Amazon region. The adoption of compulsory notification of CD in the chronic phase starting this year will allow a more real dimensioning of this endemic, since, in addition to removing many affected by the disease from invisibility, it will improve the data system for the implementation of more efficient means of disease prevention and access to treatment by the affected populations, leading to a more detailed epidemiological panorama of CD in the future.

Author Contributions

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Conflicts of Interest

There are no conflicts of interest.

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Resumo

Introdução: A doença de Chagas (DC) é uma enfermidade causada pelo protozoário flagelado da ordem Kinetoplastida denominado *Trypanosoma cruzi*. Estima-se que oito milhões de pessoas estejam infectadas em todo o mundo, principalmente na América Latina, causando incapacidades e mais de dez mil mortes por ano.

Objetivo: Descrever o panorama epidemiológico da doença de Chagas na Amazônia Ocidental brasileira no período de 2007 a 2018.

Método: Trata-se de um estudo ecológico e com coleta e análise de dados referentes aos casos confirmados de infecção por *T. cruzi* nos estados do Acre, Amazonas, Rondônia e Roraima, por meio de fontes secundárias oriundos do Sistema de Informação de Agravos de Notificação do Sistema Único de Saúde (SINAN) do Departamento de Informática do Sistema Único de Saúde (DATASUS). Os dados foram utilizados para caracterizar o perfil epidemiológico dos infectados por *T. cruzi* e determinar a frequência da infecção na Amazônia Ocidental.

Resultados: Houve a notificação de 184 casos de doença de Chagas na Amazônia Ocidental com mais registros nos estados do Amazonas e Acre.

Conclusão: O panorama epidemiológico da Amazônia Ocidental Brasileira no período de 2007 a 2018, compreende uma maior quantidade de casos em indivíduos do sexo masculino, na faixa etária dos 20-39 anos, e provenientes de zona rural. A forma de contágio prevalente na região durante o estudo foi a oral e a maior sazonalidade compreendeu os meses de abril e dezembro. Dados epidemiológicos são um importante recurso para a compreensão da dinâmica da DC e os principais aspectos relacionados no processo saúde-doença.

Palavras-chave: dados epidemiológicos, epidemiologia, tripanossomíase americana.

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