Research, Society and Development, v. 12, n. 6, e14912642199, 2023
(CC BY 4.0) | ISSN 2525-3409 | DOI: http://dx.doi.org/10.33448/rsd-v12i6.42199

Chagas disease in the Brazilian Northeast: understanding health and living conditions in a population with a historical transmission risk in the rural area

Doença de Chagas no Nordeste brasileiro: compreendendo as condições de saúde e vida em uma população com risco histórico de transmissão na zona rural

Enfermedad de Chagas en el Noreste de Brasil: comprensión de las condiciones de salud y de vida en una población con riesgo histórico de transmisión en áreas rurales

Received: 06/03/2023 | Revised: 06/10/2023 | Accepted: 06/11/2023 | Published: 06/15/2023

Weber de Santana Teles
ORCID: https://orcid.org/0000-0003-1770-8278
Centro de Hemoterapia de Sergipe, Brazil
E-mail: arteecura@hotmail.com
Maria Hozana Santos Silva
ORCID: https://orcid.org/0000-0001-5742-5366
Faculdade Ages de Medicina, Brazil
E-mail: hosana_p@hotmail.com
Max Cruz da Silva
ORCID: https://orcid.org/0000-0002-6944-5986
Secretaria Municipal de Saúde de Poço Redondo, Brazil
E-mail: maxlfi@hotmail.com
Marcel Vinícius Cunha Azevedo
ORCID: https://orcid.org/0000-0002-5312-3333
Universidade Tiradentes, Brazil
E-mail: marcelvinicius49@gmail.com
Silvia Maria da Silva Sant'ana Rodrigues
ORCID: https://orcid.org/0000-0003-2421-8701
Universidade Federal de Sergipe, Brazil
E-mail: profenf.silviasantana@gmail.com
Aline Barreto Hora
ORCID: https://orcid.org/0000-0002-3930-6475
Faculdade do Nordeste da Bahia, Brazil
E-mail: aline.barretoh@hotmail.com
Ana Fátima Souza Melo de Andrade
ORCID: https://orcid.org/0000-0002-7024-6175
Universidade Federal de Sergipe, Brazil
E-mail: anafatimamelo@hotmail.com
Joana Suely de Castro Santos
ORCID: https://orcid.org/0009-0008-0052-2702
Faculdade Pio Décimo, Brazil
joanascastro12@hotmail.com
Taíssa Alice Soledade Calasans
ORCID: https://orcid.org/0000-0003-0460-4437
Universidade Tiradentes, Brazil
E-mail: taissa.asc@gmail.com
Ângela Maria Melo Sá Barros
ORCID: https://orcid.org/0000-0003-4087-3247
Universidade Federal do Rio de Janeiro, Brazil
E-mail: angelsamelo@hotmail.com

Abstract
Chagas disease (CD) is considered a neglected disease by the World Health Organization and requires priority from the health authorities of the American continent. In Brazil, few data are available to evaluate the real situation of endemic areas for CD, mainly in the Northeast region. Thus, the objective of the study was to evaluate the living conditions, clinical aspects and prevalence of infection in inhabitants of rural areas endemic to CD. Blood was collected and submitted to diagnostic ELISA and indirect immunofluorescence techniques. A questionnaire covering sociodemographic information and knowledge related to CD was applied, and general clinical evaluation and swallowing assessment were performed. Twenty-four (7.04%) seropositive individuals were identified, of whom 83.3% were women with most in the age range of 30-60 years old. The majority of the population has a low level of education.

Regarding the risk variables for CD, an association was noted between the presence of kissing bugs (OR 9.8) and contact/manipulation (OR 20.2), transfusion (OR 10.6), and sugarcane juice intake (OR 5.1). Was possible to detect changes in swallowing. The present study revealed the existence of a population seropositive for CD without follow-up for their health condition. In addition, some of these patients present changes in swallowing that may be related to the chronic phase. Although no infected children were identified, the area may be considered at risk due to the environmental and socioeconomic conditions of its population and the presence of infected vectors previously found in the area.
Keywords: Chagas disease; Seroepidemiologic studies; Risk factors; Signs and symptoms.

Resumo
A doença de Chagas (DC) é considerada uma doença negligenciada pela Organização Mundial da Saúde e requer prioridade das autoridades sanitárias do continente americano. No Brasil, poucos dados estão disponíveis para avaliar a real situação das áreas endêmicas para DC, principalmente na região Nordeste. Assim, o objetivo do estudo foi avaliar as condições de vida, aspectos clínicos e prevalência da infecção em habitantes de áreas rurais endêmicas para DC. O sangue foi coletado e submetido a ELISA diagnóstico e técnicas de imunofluorescência indireta. Foi aplicado um questionário com informações sociodemográficas e conhecimentos relacionados à DC, avaliação clínica geral e avaliação da deglutição. Foram identificados 24 (7,04%) indivíduos soropositivos, dos quais 83,3% eram mulheres com a maioria na faixa etária de 30 a 60 anos. A maioria da população tem baixo nível de escolaridade. Em relação às variáveis de risco para DC, observou-se associação entre presença de barbeiros (OR 9,8) e contato/manipulação (OR 20,2), transfusão (OR 10,6) e consumo de caldo de cana (OR 5,1). Foi possível detectar alterações na deglutição. O presente estudo revelou a existência de uma população soropositiva para DC sem acompanhamento de sua condição de saúde. Além disso, alguns desses pacientes apresentam alterações na deglutição que podem estar relacionadas à fase crônica. Embora não tenham sido identificadas crianças infectadas, a área pode ser considerada de risco devido às condições ambientais e socioeconômicas de sua população e à presença de vetores infectados previamente encontrados na área.
Palavras-chave: Doença de Chagas; Estudos soroepidemiológicos; Fatores de risco; Sinais e sintomas.

Resumen
La enfermedad de Chagas (EC) es considerada una enfermedad desatendida por la Organización Mundial de la Salud y requiere prioridad de las autoridades sanitarias de las Américas. En Brasil, hay pocos datos disponibles para evaluar la situación real de las áreas endémicas de EC, principalmente en la región Nordeste. Así, el objetivo del estudio fue evaluar las condiciones de vida, aspectos clínicos y prevalencia de infección en habitantes de áreas rurales endémicas para EC. Se recogió sangre y se sometió a ELISA de diagnóstico ya técnicas de inmunofluorescencia indirecta. Se aplicó un cuestionario con información sociodemográfica y conocimientos relacionados con la EC, evaluación clínica general y evaluación de la deglución. Se identificaron 24 (7,04%) individuos seropositivos, de los cuales el 83,3% eran mujeres, con mayoría en el grupo de edad de 30 a 60 años. La mayoría de la población tiene un bajo nivel educativo. En cuanto a las variables de riesgo para EC, hubo asociación entre la presencia de barberos (OR 9,8) y contacto/manipulación (OR 20,2), transfusión (OR 10,6) y consumo de jugo de caña (OR 5,1). Fue posible detectar cambios en la deglución. El presente estudio reveló la existencia de una población seropositiva a EC sin seguimiento de su estado de salud. Además, algunos de estos pacientes tienen cambios en la deglución que pueden estar relacionados con la fase crónica. Aunque no se identificaron niños infectados, la zona puede considerarse de riesgo por las condiciones ambientales y socioeconómicas de su población y la presencia de vectores infectados encontrados previamente en la zona.
Palabras clave: Enfermedad de Chagas; Estudios seroepidemiológicos; Factores de riesgo; Signos y síntomas.

1. Introduction

Human Chagas Disease (CD), which is caused by the flagellate *Trypanosoma cruzi*, is considered a predominantly rural endemic disease with an estimated prevalence of infection from six to seven million individuals worldwide concentrated in several countries of the American continent. However, the migration of infected individuals to countries outside the American continent has caused the disease to reach non-endemic countries, which has led to transmission of parasitic infection by non-vector mechanisms (Dias et al., 2011).

According to recent estimates, 5.7 million individuals infected with CD reside in Latin American nations, including Argentina (26.2%), Brazil (20.1%), Mexico (15.3%) and Bolivia (10.6%) (Dias et al., 2016). Despite the large number of individuals infected with *T. cruzi*, a number of Latin American countries have made substantial progress in controlling CD. The estimated prevalence of *T. cruzi* infection decreased from 30 million infected individuals in 1991 when the first regional control initiative started to approximately 5.7 million infected individuals in 2010 (Dias et al., 2011).

Among the various forms of CD transmission, vector and oral pathways are currently the most important. The latter form has been occurring frequently in several South American countries and requires new prevention strategies (Martins et al., 2014).

In 2014, the Brazilian Ministry of Health estimated the existence of two to three million people with CD; however, the evaluation of the actual estimate of the prevalence of CD in Brazil is difficult due to the inaccuracy of the information provided (Brasil, 2014). Information on deaths due to acute CD between 2005 and 2013 indicate that the mean annual lethality rate in Brazil during the period was 3.7% (Brasil, 2015).

In contrast to individuals with acute infection, which is typically the result of oral infection, the epidemiological profile of the chronic chagasic patient in Brazil points to an individual of rural origin with a low level of education for which vector transmission is the most likely cause of infection[1]. In addition, the delay in diagnosis can lead to the development of severe forms of the disease and interfere with the prognosis (Brasil, 2012).

In the Northeast region of Brazil, CD has been identified as the second most common parasitosis in terms of the number of infected individuals according to triatomine infestation indexes in the national surveys of the prevalence and distribution of vectors performed between 1975 and 1980 (Dias, 2010). Thirty years since this survey, the Brazilian Northeast is still concerned about the risk of CD transmission due to the presence of several species of infected triatomines (Vinhaes, 2000).

According to studies and official records of municipal epidemiological surveillance, the epidemiological situation of CD in the state of Sergipe reveals a pattern of mismatched information. In the period between 2005 and 2009 he was reported 86 acute cases of CD in the state of Sergipe according to data obtained directly from the health centres. In addition, 81.4% of these cases exclusively occurred in the municipality of Itabaianinha. In contrast, data from the Ministry of Health indicate that only two cases of acute CD have been reported in Sergipe in the period 2000-2013, and information on chronic cases was not available (Brasil, 2015; Brasil, 2012).

Systematized actions to control CD in the state of Sergipe were initiated in 1974. In the period 1975-1980, the seroprevalence in the State was estimated at 5.97%. Thus, this State was classified as an area of risk for transmission of the parasitosis (Silveira et al., 2011; Barbetta, 2011).

From this perspective, the objective of the study was to evaluate the living conditions, clinical aspects and prevalence of *T. cruzi* infection in inhabitants of rural areas endemic to CD in the context of the monitoring process, chronic case research and control of endemics in Northeast Brazil.

2. Methods

The research was performed in the rural area of the municipality,withLatitude: -11.2743, Longitude: -37.7889 11 ° 16 ′ 27 ″ South, 37 ° 47 ′ 20 ″ West n the Northeast of Brazil, specifically in the agreste of the State of Sergipe. The agreste is characterized as a transition region between the Atlantic Forest and Caatinga biomes, in which a large number of species of triatomines and various ecological niches that contribute to the maintenance of CD in the region can be found (Requena et al., 2015). The region has an area of 480.4 km^2. Specifically, the villages of Mutuca, Piabas, Fundão and Água Boa presented the highest index of triatomine infestation domiciliary/natural infection according to data from the Control Program of CD (Programa de Controle da Doença de Chagas - PCDCh).

A 1-year (between October 2012 and September 2013) cross-sectional was conducted in the population living in the previously mentioned villages, regardless of sex or age.

A total of 1,041 individuals, which is the total number of inhabitants of the area, were considered for estimating the size of the population sample. A minimum sample size for the serological survey was performed according to Barbetta (Jansen et al.,

2017), (tolerable sample error of 5%). The minimum sample size was 289 individuals. However, all residents were invited to participate in the study, totalling 341 individuals, which represents 32.7% of the total residents living in the study area.

Initially, there was an exposition of topics related to CD through lectures given for health agents and for the community in general with the purpose of explaining the objectives and importance of the research with the support of the Epidemiological Surveillance Coordination. Subsequently, all the villages were visited, and information standardized by the PCDCh was obtained. Clinical and serological evaluations were conducted.

The standard PCDCh form was applied to individuals over 18 years of age to obtain information regarding gender, age, educational level, type of housing, knowledge of and contact with triatomine, transfusion, sugarcane juice ingestion, waste disposal, presence of animals, therapeutic treatment, and previous diagnosis as a chagasic patient.

To perform the serological evaluation, 10 ml of peripheral blood was collected by venipuncture from the volunteer participants of the research regardless of age. The serum obtained was stored in a freezer at -20ºC until the ELISA and Immunofluorescence serological tests were performed. Serological tests by the ELISA technique (GOLD ELISA CHAGAS®) were performed at the Serology Laboratory of the Blood Centre of Aracaju/SE (Hemocentro Coordenador de Aracaju/SE – HEMOSE) and were also repeated at the Central Laboratory of Sergipe (Laboratório Central de Sergipe - LACEN-SE). Immunofluorescence diagnostic techniques were performed at the Laboratory of Serology of LACEN-SE.

Clinical evaluation was performed after the serological evaluation in individuals with positive and negative anti-Chagas serology who were over 18 years old and were asked about the presence of signs and symptoms, such as daily fever, malaise, myalgia, asthenia, anorexia, headache, lymphadenopathy and gastrointestinal disorders. The individuals were submitted to a detailed physical examination, such as palpation, percussion and auscultation, seeking to show symptoms related to the digestive and cardiovascular systems.

For the clinical assessment of swallowing, a previously established protocol was used (Silva, 2004; Bretan & Henry, 1997). After anamnesis, each participant was submitted to the specific clinical evaluation of swallowing performed in two stages: indirect and direct.

Indirect evaluation was performed without administration of diet via the oral route. The mobility of the phonoarticulatory organs was observed with movements of lateralisation of the tongue to the left and right (normal or altered) as well as protrusion and retraction of the lips (normal or altered). In the direct evaluation, an oral diet of liquid consistency (60 ml of water) and pasty consistency (6 g of corn starch diluted in 60 ml of water) was administered. Lip seal, laryngeal elevation, cough, vocal quality, nasal regurgitation and presence of food residues in the mouth were evaluated (Lescure et al., 2010).

The project was approved by the Human Research Ethics Committee of the Tiradentes University (Universidade Tiradentes), Aracaju/SE (Process no. 190610R). All adults and those responsible for minors signed the Free and Informed Consent Form after presenting the research objectives and procedures. The data collected were used exclusively for the purposes outlined in the protocol.

The data obtained were analysed with descriptive statistics and frequency distributions. In addition, odds ratios were calculated. The following were considered risk factors: type of dwelling; presence, manipulation or contact with the kissing bug; knowledge about contamination and prevention; and other variables. The tests were performed using the statistical package SPSS (version 15.0) and BioEstat 5.0, and a confidence interval of 95.0% was adopted.

3. Results

Of the 341 subjects submitted to the serological evaluation, 24 were serum reagents in the two diagnostic tests used, representing a prevalence of 7.04% in the evaluated population. Women accounted for approximately 80% (19 of 24) of the Chagasic population; however, the differences regarding sex were not significant ($p = 0.41$).

A questionnaire on socio-demographic and knowledge aspects of CD was applied to all study participants over 18 years old, namely, a group of 132 adult residents who were predominantly female (75%). The majority of individuals seropositive for CD were between 40 and 59 years old (Table 1).

Table 1 - Distribution by age of individuals submitted to the serological evaluation for diagnosis of CD in the rural area of Itabaianinha/SE, 2013.

Chagas disease (mean age ± SD)	Age group (years)					
	< 20-29	30-39	40-49	50-59	60-69	> 70
Positive (47.17 ± 10.57)	1	6	7	8	2	--
Negative (39.54 ± 16.44)	38	28	17	8	11	6

Source: Authors.

Regarding schooling, the population was mainly composed of illiterates and individuals with incomplete or complete elementary education (90%). When evaluated according to serology for CD, 16 of the 24 (66.6%) seropositive individuals declared themselves illiterate.

Regarding the risk factors for CD, approximately 85% of the interviewed individuals stated that they lived in a brick home, including 20 of the 24 CD-positive individuals. OR calculations did not reveal a risk ratio for WC for residents living in homes made of mud and straw or brick (Table 2).

Table 2 - Distribution of the indicators in relation to the risk factors for CD of the individuals submitted to serological evaluation in a rural area of the municipality of Itabaianinha/SE, 2013.

VARIABLE	Non Chagasic individuals (n = 108) n (%)	Chagasic individuals (n = 24)	OR	p
Type of building				
Brick	93 (70.5)	20 (15.2)	1.24	0.9767
Mud and straw	15 (11.4)	4 (3.0)	(0.3719 – 4.1339)	
Presence of the kissing bug				
Yes	57 (43.1)	22 (16.6)	9.8421	< 0.001
No	51 (38.6)	2 (1.6)	(2.2048 – 43.9350)	
Manipulation/contact with the kissing bug				
Yes	38 (28.7)	22 (16.6)	20.2632	< 0.001
No	70 (53.0)	2 (1.6)	(4.5192 – 90.8553)	
Knows how contamination occurs			-	-
Yes	-	-	-	-
No	108 (81.8)	24 (18.2)	-	-
Prevention			-	-
Yes	-	-	-	-
No	108 (81.8)	24 (18.2)	-	-
Transfusion				
Yes	2 (1.6)	4 (3.0)	10.600	0.0091
No	106 (80.3)	20 (15.1)	(1.8175 – 61.8207)	

Presence of animals				
Yes	59 (44.6)	13 (9.8)	0.9815 (0.4039 – 2.3849)	0.8529
No	49 (37.1)	11 (8.3)		
Waste destination				
Buried	26 (19.6)	2 (1.5)	X^2	0.0968
Burned	53 (40.0)	11(8.3)		
Collected	29 (21.9)	11(8.3)		
Ingestion of sugarcane juice				
Yes	40 (30.3)	18 (13.6)	5.1000	0.0016
No	68 (51.5)	6 (4.5)	1.8704 – 13.9064	

Source: Authors.

Approximately 60.0% of the respondents reported seeing triatomines in the home, and 45.3% manipulated or had contact with the insect. These variables were significant risk factors for CD. When interviewees were questioned about whether they knew how to protect themselves from the insect vector or how the infection occurs, 100% said they did not know. Although only 4.6% of the individuals reported having received blood and 43.9% said they had ingested sugarcane juice, these variables were significant risk factors for CD. On the other hand, the presence of domestic animals and waste management were not risk factors for CD (Table 2).

Regarding the clinical evaluation of indirect swallowing, changes in swallowing and vocal complaints were observed in approximately 30 and 20% of the patients with serology positive for CD, respectively (Table 3).

Table 3 - Distribution of the results of clinical evaluation of indirect swallowing in chagasic and non-chagasic individuals living in the rural area of the municipality of Itabaianinha/SE, 2013.

Variable	Non-chagasic individuals (119) n (%)	Chagasic individuals (24) n (%)
Symptoms of deglutition change		
No	119 (100)	16 (66.6)
Yes	0 (0)	8 (33.3)
Mobility of the lips		
Normal	119 (100)	24 (100)
Altered	0 (0)	0 (0)
Mobility of the tongue		
Normal	119 (100)	24 (100)
Altered	0 (0)	0 (0)
Vocal complaint		
Present	0 (0)	5 (20.8)
Absent	119 (100)	19 (79.1)

Source: Authors.

In the direct evaluation of swallowing, alteration in laryngeal elevation was observed during swallowing of liquid and pasty foods in approximately 21% of the individuals with positive serology for CD. Regarding the evaluation of multiple

swallows for the two types of food, an increased frequency of change was observed in the group with positive serology for CD (Table 4).

Table 4 - Distribution of the results of clinical evaluation of direct swallowing in chagasic and non-chagasic individuals living in the rural area of the municipality of Itabaianinha/SE, 2013.

Variable	Non-chagasic individuals (119) n (%)	Chagasic individuals (24) n (%)
Lip sphincter		
Pasty food		
Normal	119 (100)	24 (100)
Changed	0 (0)	0 (0)
Liquid food		
Normal	119 (100)	24 (100)
Changed	0 (0)	0 (0)
Laryngeal elevation		
Pasty food		
Reduced	0 (0)	5 (20.8)
Normal	119 (100)	19 (79.1)
Liquid food		
Reduced	0 (0)	5 (20.8)
Normal	119 (100)	19 (79.1)
Multiple swallowing		
Pasty food		
Yes	1 (0.8)	7 (29.1)
No	118 (99.1)	17 (70.8)
Liquid food		
Yes	0 (0)	6 (25)
No	119 (100)	18 (75)
Cough		
Pasty food		
Yes	0 (0)	0 (0)
No	119 (100)	24 (100)
Liquid food		
Yes	0 (0)	0 (0)
No	119 (100)	24 (100)
Oral Residue		
Pasty food		
Yes	0 (0)	0 (0)
No	119 (100)	24 (100)
Liquid food		
Yes	0 (0)	0 (0)
No	119 (100)	24 (100)

Source: Authors.

An increased frequency of symptoms related to difficulty swallowing, such as dysphagia, gagging, regurgitation, reflux, and vocal complaint, was observed among the subjects with positive serology for CD (Table 5). Of note, an individual with positive serology reported having previous oesophageal surgery. Some clinical manifestations have also been reported, such as tachycardia, arrhythmia, and asthenia in individuals positive for CD.

Table 5 - Distribution of swallowing-associated alterations and cardiac changes of 24 individuals positive for CD from the rural area of the municipality of Itabaianinha/SE, 2013.

Changes associated with swallowing		
Variable	Yes n (%)	No n (%)
Dysphagia	8 (33.3)	16 (66.6)
Choking	7 (29.1)	17 (70.8)
Regurgitation	3 (12.5)	21 (87.5)
Reflux	4 (16.6)	20 (83.3)
Vocal complaint	5 (20.8)	19 (79.1)
Sensation of food stuck	4 (16.6)	20 (83.3)
Cough	5 (20.8)	19 (79.1)
Respiratory change	4 (16.6)	20 (83.3)
Weight loss	4 (16.6)	20 (83.3)
Water to help during swallowing	6 (25)	18 (75)
Diet change	3 (12.5)	21 (87.5)
Cardiac clinical manifestations		
Asymptomatic	15 (62.5)	9 (37.5)
Oedema of face and limbs	0 (0)	0 (0)
Asthenia	5 (20.8)	19 (79.1)
Signs of heart failure	0 (0)	0 (0)
Persistent tachycardia	9 (37,5)	15 (62,5)
Arrhythmia	9 (37,5)	15 (62,5)

Source: Authors.

4. Discussion

In recent years, important efforts have been made towards controlling the transmission of CD in endemic areas based on vector control and transfusion safety. However, the epidemiological picture of CD has become more complex due to the number of reservoir animals and vectors involved in the domestic and peridomestic transmission cycles, all of which are associated with different environmental and socio-political conditions peculiar to each region (Martins et al., 2014). Thus, research on endemic areas is relevant due to the lack of knowledge of current transmission mechanisms and the lack of prevalence data of individuals infected in the chronic phase. In the most recent Brazilian mapping performed through meta-analysis, the state of Sergipe was not included because there was no official record of CD in the region (Carvalho et al., 2000).

The non-existence of infected individuals among children, adolescents and young adults (<30 years) in the studied region of Sergipe state represents an important indicator of the reduction in vector transmission rates, highlighting the effectiveness of the campaigns focused mainly on vector control. However, it is important to note that many of the conditions considered risks for vector transmission remain in the studied area with focal expression, such as that observed in the state of Sao Paulo (Borges et al., 2007).

The prevalence of chagasic infection in the rural area of Itabaianinha was 7.04%. This value represents a greater than two-fold increase in the prevalence observed in the state of Ceará (3.1%), which is also located in the Northeast region of Brazil (Gontijo et al., 2006). Similar to this work, studies have demonstrated that females exhibit the highest infection rates[4] due to their higher vulnerability to the disease and likely due to their habit of sleeping while leaning against the wall for thermal comfort (windows and/or sunlight) or their longer permanence inside the home compared with men, which would facilitate contact with the vector or its faeces (Borges et al., 2007).

The rural population of Itabaianinha is characterized by low education levels and poor financial conditions, which may contribute to the poor knowledge of the disease expressed by the residents. The same situation is evidenced in other populations in which CD patients have mostly low educational levels (Black et al., 2007). The chagasic individual has been historically associated with a segment of the population with low socioeconomic status, low education levels, and low income, which marginalizes and exposes an individual to diseases such as CD (Bretan et al., 1997).

Some residents of the area observed in the present study reported having seen and even touched the triatomine, and these risk factors were significant in relation to the risks of acquiring CD. The domiciliation of vectors, which represents a potential factor of relative local safety, is a worrisome phenomenon regarding transmission. Trypanosomiasis vectors are able to colonize human homes that have favourable conditions, including houses made of mud and straw and other building materials (clay, thatched roofs, etc.). These vectors are derived from the wild and can be found in the peridomiciliary area or inside the home, induced by microclimatic modifications and food supply and leading to the dispersion and occupation of new ecological niches[24]. Thus, the improvement of human housing became a CD control measure that was adopted by the Brazilian Ministry of Health in 1967 (Camargo et al., 1984).

On the other hand, in some settlements in Itabaianinha, the production of ceramics was responsible for the disordered deforestation, which together with agricultural activities such as citriculture may have contributed to the dispersion of the triatomines to the peridomiciliary area and inside the home; in addition, these conditions are associated with factors such as the precariousness of human dwellings and abundant food that have favoured the domiciliation process of vectors of *T. cruzi* (Camargo et al., 1984). Undoubtedly, the fact that triatomines colonize the peridomiciliary area is a risk factor for CD in the area.

In Latin America, the various types of building materials used in human dwellings and peridomiciliary characteristics are identified as factors associated with *T. cruzi* infection given that these factors can influence infestation in homes and nearby areas (Maeda et al., 2012). In the rural area of Itabaianinha, approximately 80% of the population lives in brick houses, demonstrating a substantial improvement and positive impact on CD vector transmission in the region. However, home additions used for various purposes that present ideal characteristics for the triatomine shelter are often observed. These features certainly pose risks to the residents.

Chemical control of the insect vector was essential to reducing the human transmission of *T. cruzi* mainly related to *Triatoma infestans* (Villela et al., 2012). However, as previously discussed, other triatomines have occupied the ecotypes left by *T. infestans*. As noted in the present study, other studies report that individuals from endemic areas observed the triatomine within the home (Moraes et al., 2011), however, this information should be carefully evaluated due to the difficulty of identifying the vector insect that can be mistaken with other insects. The current situation in the study area demonstrates that prevention and

control actions are paralyzed, which is reflected in the lack of knowledge of the majority of respondents regarding the form of infection and the vector.

In blood banks in Brazil, transmission of CD is almost non-existent due to strict transfusion control (Angheben et al., 2015). However, it is still possible to find reports of transmission via blood transfusion in some countries, mainly in Europe, originating from chagasic individuals from Latin America (Ries et al.,2016; Jansen et al., 2017). In the study area, approximately 16% of patients with CD reported having received blood transfusion, representing a significant risk factor for acquiring the disease.

Domestic and farmed animals found near dwellings can be considered risk factors for CD given that the parasite can use these hosts in the varied ecological niches found in the peridomiciliary area of rural areas. Simultaneously, wild animals that contribute to the dispersion of the parasite can be attracted to the area (Meyers et al., 2017). Domestic animals have been reported as important reservoirs of *T. cruzi*, including dogs that can become infected by ingesting infected triatomines or coming into contact with faeces of these insects (Walter, 2007). In the study area of Sergipe, approximately 50% of respondents reported living with domestic animals; however, this condition was not identified as a risk factor for CD. In this ecological context, the presence of *Didelphis* species (possums) has been recognized as a strong indicator of environmental disturbance (Singh, et al., 2005; Brasil, 2005), which makes these animals more susceptible to infection by *T. cruzi*.

Because it is rural, the area studied does not have a regular garbage collection system, which causes most of the residents to burn or bury their garbage. The lack of management of domestic waste can attract insects and other animals, contributing to the dispersion of *T. cruzi* and increasing the risk of human infection (Sangenis, 2016). However, in this research, this variable was not identified as a risk factor.

In Brazil, oral transmission is currently considered the main form of transmission of CD. This route has been reported with increasing frequency since 2005, when an outbreak of CD was triggered in the state of Santa Catarina in the southern region of Brazil where the transmission occurred through the consumption of sugarcane juice (Santos, et al., 2011). In the Northeast region of Brazil, oral transmission is not often reported and is often underestimated. In the study area, ingestion of sugarcane juice has not been reported as a frequent practice. Although sugarcane juice ingestion may be considered a significant risk factor for CD transmission, the possibility that other forms of oral infection may occur in the region remains (Dantas, et al., 2009).

Symptomatic chronic CD can present with swallowing abnormalities; therefore, the evaluation of this function becomes relevant in seropositive individuals. According to Dantas et al., (2009), reduced laryngeal elevation and elevation and interiorization of the hyolaryngeal complex are noted in combination with opening of the pharyngoesophageal transition or upper oesophageal sphincter (UOS), which occurs in conjunction with ejection of the swallowed bolus. These features are important for laryngeal protection. Increased frequencies of multiple swallowing and reduced laryngeal elevation were observed in the population of the present study compared with healthy subjects swallowing foods with liquid and pasty consistencies. In chagasic individuals, this mechanism affects the swallowing process given the lack of correct elevation of the larynx, resulting in a reduction in the UOS opening and prolonged time of food in the pharynx. These factors increase the probability of aspiration.

The lower opening of the upper oesophageal sphincter and elevation of the larynx may be related to the impairment of food swallowing with diverse consistencies in chagasic individuals (Cunha, et al., 2005). These alterations have been observed more frequently in individuals of the group positive for CD in swallowing foods with both pasty and liquid consistencies (Gee et al., 2017).

Alterations such as regurgitation and weight loss have been reported in approximately 12 and 16% of respondents, respectively, demonstrating the need for follow-up to determine whether these changes are due to CD or other diseases. Research performed on chagasic individuals revealed that small amounts of food from regurgitation can cause bad breath and that 42% of individuals positive for CD reported losing weight (Sanmartino, 2009).

Cardiac changes were reported by 37.5% of CD patients. In the chronic infection phase, chagasic cardiomyopathy is the most severe clinical form and initially manifests in different forms, such as effort intolerance, palpitations and syncopal conditions resulting from arrhythmia (Cunha et al., 2005). Thus, the early diagnosis of CD and its adequate management are of fundamental importance for the quality of life of the *T. cruzi* carrier.

As noted in many other health situations, given that some goals related to the control and epidemiological surveillance of CD are achieved and the incidence of the disease is reduced, financing becomes scarcer. This is particularly true in the municipality under study, in which the actions of the CD Control Program are not performed systematically and continuously. This discontinuity is the reality of many rural areas in northeastern Brazil, where little is known about the dynamics of infection. According to Gee and Skovdal., (2017), the study area could be considered a 'riskscape', a term used to refer to places or environments associated with significant risks for contracting diseases. In this concept, a socioecological approach and a broader analytical perspective are used to identify the set of individuals, interpersonal relationships, and environmental and political factors that increases vulnerability to health risks. According to these authors, the construction of the riskscapes prescinds studies of risk perception at a microlevel and regards the relative security of the domestic space as one of the most effective local factors affecting the transmission of vector diseases.

The results obtained with respect to the dynamics of CD in the municipality of Itabaianinha/SE allow us to infer that the lack of information regarding the mechanisms of transmission, the clinical forms of the disease, and their respective symptoms, therapeutics and prevention strategies is a reflection of the absence of specific health education actions combined with the low educational level of the population. Although no children were infected with *T. cruzi*, it is important to note that many of the conditions considered risks for vector transmission remain in the researched areas.

Increased knowledge about CD will lead to advances in the control of this parasitic infection and its vectors. Thus, inhabitants of endemic areas could better understand their reality and acquire habits that allow them to be in control of their well-being. Control actions should be maintained and intensified to better meet the needs/expectations of communities in rural areas, providing subsidies for the formulation of health promotion strategies and actions that will contribute more effectively in the prevention of CD the and humanization of the attention given to the CD carrier and residents of the risk area (Walter, 2007).

Of note, only one of the 24 individuals serum-positive for CD was aware of their carrier status, clearly demonstrating the lack of knowledge about the prevalence of infection in rural communities in endemic areas. This fact may clearly affect the health of these individuals, who in addition to being unaware of having CD, have poor access to health and therefore the follow-up that could contribute to a higher life expectancy and better quality of life should they develop some clinical involvement in the chronic phase.

The context of difficulties such as road access to the studied communities and cardiological/digestive exams of greater complexity that can aid in diagnosis and prognosis is also reported here. All the results obtained were sent to the Municipal Health Secretariat of Itabaianinha in Sergipe to provide subsidies for the actions of the Local CD Control Program (Programa de Controle de DC local - PCDCH). A disease is always more than a disease; it is a network of relations and fissures that reveal the multidimensionality of this population that resides in the Brazilian agreste under historical risk of CD transmission.

5. Conclusion

Our results provide evidence that areas considered endemic for CD require constant monitoring of their populations with the main objectives of identifying individuals in asymptomatic chronic phase and constantly evaluating the possibility of new cases of CD and their possible forms of transmission. This study was performed in a restricted geographic area, which can reveal the multiplicity of situations faced by populations impacted by CD transmission. Knowledge of the particularities of each CD transmission site can guide specific actions that contribute directly and indirectly to the health of the individuals, thus

improving the health conditions of specific populations. Of note, although the study area was considered at other times an area of high risk of transmission, practically no information is available from epidemiological surveillance at present. These findings reveal how these communities do not receive proper care regarding CD and likely other diseases.

It is seen that, despite the study carried out, it is necessary to carry out new productions that may deepen this theme and strengthen the importance of prevention in Chagas disease, the implementation of programs and incentives for prevention and knowledge about the disease should be increasingly stimulated and studied within health services.

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