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Trypanosoma cruzi antibodies

in blood donors in Yucatan state, Mexico

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Resumen

Introducción: la transfusión de sangre es la segunda vía más frecuente de transmisión de *Trypanosoma cruzi* en muchos países latinoamericanos. El objetivo de este estudio fue documentar la distribución de anticuerpos contra *T. cruzi* en Yucatán e identificar las regiones con mayor prevalencia de donadores de sangre seropositvos.

Métodos: los datos fueron recolectados a partir de donaciones de sangre en el Banco Central de Sangre del Hospital de Especialidades, Centro Médico Nacional "Ignacio García Téllez", en el periodo de 2002 a 2007.

Resultados: la reactividad a los anticuerpos contra *T. cruzi* se determinó en 86 343 donadores de sangre. La seroprevalencia global fue de 0.70 %. De 2002 a 2004, 58 % de los donadores seropositivos residía en el área rural, de 2005 a 2007, 56.6 % en el área urbana. Las seroprevalencias más altas por región fueron en el área metropolitana (0.42 %) y en el sur del estado (0.09 %). La mayoría (60.3 %) de los donadores seropositivos residía en el municipio de Mérida.

Conclusiones: la distribución de la seroprevalencia fue heterogénea durante el periodo de estudio, pero la transmisión urbana aparentemente ha superado la transmisión rural en los últimos años.

Palabras clave

Trypanosoma cruzi
enfermedad de Chagas
donadores de sangre

Summary

Background: blood transfusion is the second most frequent way of *Trypanosoma cruzi (T. cruzi)* transmission in Latin American countries. Few data exists on the geographic distribution and prevalence of *T. cruzi* seropositive blood donors in Mexico. The objective was to document *T. cruzi* antibody distribution, and identify the regions with the highest prevalence of seropositive blood donors.

Methods: the analyzed data was collected over a six-year period during blood donations made at the Central Blood Bank and at the transfusion services and donation modules of the Instituto Mexicano del Seguro Social (IMSS) located in the Yucatan state.

Results: *Trypanosoma cruzi* antibody reactivity was determined in 86343 blood donors. Overall seroprevalence was 0.70 % (607/86 343). Since 2002 to 2004, the majority (58 %) of seropositive donors were rural residents, but since 2005 to 2007 the majority (56.6 %) were urban residents. The two highest seroprevalences by region were in the Metropolitan area (0.42 %) and in rural south Yucatan (0.09 %). Most seropositive donors resided in the municipality of Merida (60.3 %).

Conclusions: seroprevalence distribution was heterogeneous during the study period but urban transmission has apparently surpassed rural transmission in recent years.

Key words

Trypanosoma cruzi
Chagas disease
blood donors

Introduction

The protozoarian parasite *Trypanosoma cruzi (T. cruzi)* is the causal agent of Chagas disease, a parasite disease that is still a serious public health problem in Latin America. The World Health Organization estimates that in the Americas 8-9 million people are infected with *T. cruzi* and up to 25 million more may be at risk of infection.[1] In general, *T. cruzi* infection is most prevalent among rural populations, particularly those living in poor-quality housing (e.g. waddle-and-daub walls, thatched roof) with crevices that can provide refuge for insect vectors.[2] Transmission of *T. cruzi* to humans is via contact with the faeces of infected triatomid insects and blood transfusion.[3,4] There are also reports of transmission by organ transplant from

infected donors and congenital transmission.[5-8] Human migration from rural to urban areas has increased the frequency of Chagas disease in the latter and made it a public health problem in non-endemic countries (e.g. the United States).[9,10]

Blood safety remains a worldwide concern, especially in developing countries. Those with medium to low per capita income levels, such as Latin America and sub-Saharan Africa, have not attained 100 % screening for human immunodeficiency virus, hepatitis B and C viruses and syphilis.[11,12] In Latin America, screening for *T. cruzi* ranges from 25 to 100, with the lowest levels in Costa Rica, Mexico and Panama.[13]

Infection prevalence of *T. cruzi* in humans varies by geographic region and studied population. In Mexico, federal law (NOM-003-SSA2-1993) dictates that serological tests for anti-*T. cruzi* antibodies must be done on blood donors in endemic zones, but no indication is given to zones, where are endemic. Studies of Mexican blood banks have demonstrated that seropositivity for these antibodies in blood donor ranges from 0.48 to 17 %,[14,15] and studies in non-endemic zones such as Mexico City and Puebla have documented seroprevalence in blood donors of 0.37 % and 7.7 %, respectively.[9,16]

A geographic distribution study of Triatoma dimidiata, the main insect vector of *T. cruzi* on the Yucatan state, showed that approximately 1.6-1.7 million people in this region could be *T. cruzi* transmission risk, and that over 90 % of them live in the Yucatan state.[17] Despite this high risk level, little data is available on the seroprevalence of *T. cruzi* antibodies in blood donors and the clinical status of seropositive subjects. The objective was to document *T. cruzi* antibody distribution in Yucatan state, and to identify the regions with the highest prevalence of seropositive blood donors. In conjunction with data on vector geographic distribution, these data may help to develop and implement control strategies and provide opportune attention to patients, reducing the probability of vector-borne transmission and lowering the number of new infections cases.

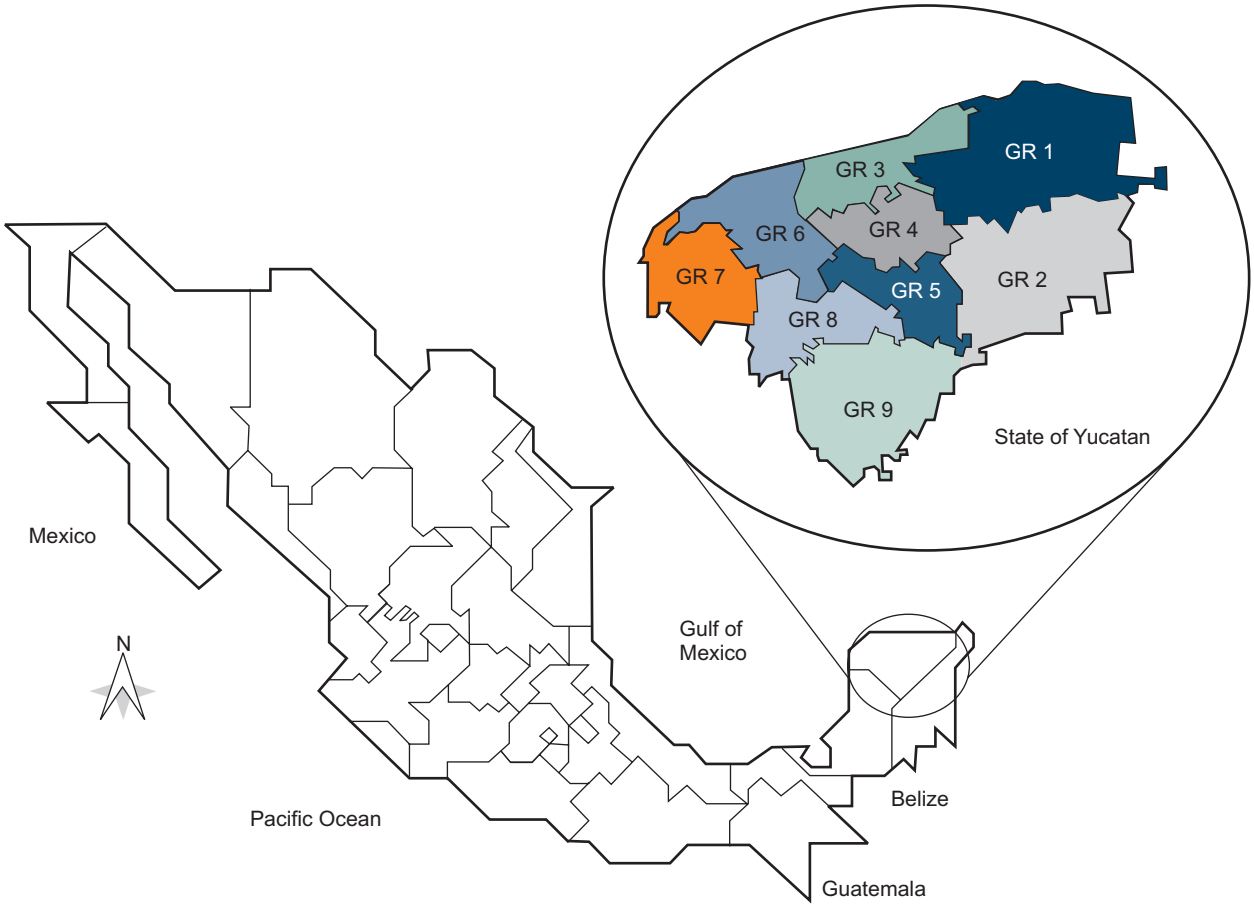

Figure 1 Geographical regions (GR) as designated by the INEGI within Yucatan state, Mexico: GR1, East Coast; GR2, East; GR3, Central Coast; GR4, Centre; GR5: South Central; GR6, Metropolitan Area; GR7, West Coast; GR8, Southwest; and GR9, South.

Table I Seroprevalence of *Trypanosoma cruzi* antibodies in blood donors from 2002 through 2007

Year (*n* total)	Seroprevalence *n*	%
2002 (*n* = 12575)	86	0.68
2003 (*n* = 12843)	121	0.94
2004 (*n* = 14515)	107	0.74
2005 (*n* = 13646)	96	0.70
2006 (*n* = 16017)	97	0.61
2007 (*n* = 16747)	100	0.60

Methods

The analyzed data was collected over a six-year period (2002-2007) during blood donations made at the Central Blood Bank, "Ignacio García Téllez" Specialties Hospital, and at the transfusion services and donation modules of the *Instituto Mexicano del Seguro Social* (IMSS) located in the nine official geographic regions of the Yucatan state and information from the *Instituto Nacional de Estadística, Geografía e Informática* (INEGI). Prospective donors were screened using questionnaires conforming to Mexican health law (NOM-003-SSA2-1993), which included items addressing history of Chagas disease, any previous transplants or transfusions and travel in areas where *T. cruzi* is endemic. All blood donations during the study period were screened for hepatitis B virus (HBV); surface antigen (HBsAg), as well as antibodies to human immunodeficiency virus (anti-HIV); hepatitis C virus (anti-HCV); *Brucella abortus* (anti-*B. abortus*) and *Treponema pallidum* (anti-*T. pallidum*). Donors gave informed consent at the time of blood donation, and the Institution Ethics Committee approved the survey.

Blood donations (2002-2005) were screened using a second-generation commercial enzyme immunoassay for qualitative detection of IgG antibodies to *T. cruzi* (Chagas ELISA Test, BiosChile Ingeniería Genética S. A., Zañartu 1482, Santiago, Chile). In 2006 and 2007, blood donations were screened with a Chagas III ELISA Test (BiosChile Ingeniería Genética S.A., Zañartu 1482, Santiago, Chile). The sensitivity and specificity of both tests reported by the manufacturer is 100 %. All the procedures used in the present study met manufacturer validity criteria. Initially reactive blood samples were run a second time and considered reactive when a reaction was observed in both analyses. Confirmation was not done due to a lack of reagents and the necessary equipment.

Descriptive statistics were calculated for the data consisted of the mean and percentage.

Results

During the study period, 86343 blood donors from the nine Geographical Regions (figure 1) were screened for anti-*T. cruzi* with the ELISA tests. Of the total number of donors, 76062 (88.10 %) were men and 10281 (11.90 %) were women, resulting in a male:female ratio of 7.4:1. Average blood donor age was 37.1 years with a range of 18-63 years. Of the 86343 samples analyzed, 607 (0.70 %) were reactive for anti-*T. cruzi*, producing an overall seroprevalence among donors of 1 in 142 (607/86 343; 0.70 %). Seroprevalence ranged from 0.60 % to 0.94 % during the study period, with the highest levels documented in 2003 (table I). In the 607 anti- *T.cruzi* seropositive donors, 557 (91.80 %) were men and 50 (8.20 %) women. Residence was evenly distributed among the seropositive donors, with 298 (49 %) living in an urban area and 309 (51 %) in the rural area. Differences in residence were noted over time. From 2002 to 2004, most seropositive donors were from rural areas while from 2005 to 2007 most were from urban areas (table II). The highest prevalence of seropositive donors was

Table II Place of residence of *Trypanosoma cruzi* antibody seropositive blood donors in Yucatan from 2002 through 2007

Year (*n total*)	Urban *n*	%	Rural *n*	%
2002 (*n* = 86)	33.0	38.4	53	61.6
2003 (*n* = 121)	52.0	43.0	69	57.0
2004 (*n* = 107)	47.0	43.9	60	56.1
2005 (*n* = 96)	56.0	58.3	40	41.7
2006 (*n* = 97)	52.0	53.6	45	46.4
2007 (*n* = 100)	58.0	58.0	42	42.0

in the Geographical Region 6 and 9 (table III). Labeled metropolitan area and Geographical Region 6 encompasses the municipality of Merida as well as 13 other municipalities, while Geographical Region 9, labeled south Yucatan, is a largely rural area. The majority (60.30 %, *n* = 366) of the anti-*T. cruzi* reactive donors lived in the municipality of Merida.

Seventeen of the anti-*T. cruzi* reactive donors were also positive for other antibodies: two with anti-HIV; one with anti-*B. abortus*; one with HBsAg; seven with anti-HCV; and six with syphilis. Overall anti-*T. cruzi* seroprevalence was higher during the study period than the seroprevalences for anti-HIV (0.10 %, *n* = 87); anti-HCV (0.34 %, *n* = 298); anti-*T. pallidum* (0.24 %, *n* = 203); anti-B. abortus (0.13 %, *n* = 112) and HBsAg (0.16 %, *n* = 136).

Discussion

Data on Chagas disease in Mexico is scarce and the number of Chagas cases transmitted by blood transfusion is unknown. The latter is particularly worrisome since screening for *T. cruzi* infection is not required in blood banks outside endemic areas, meaning *T. cruzi* infected individuals who migrate to non-endemic areas (especially asymptomatic carriers) constitute potential transmission sources. Yucatan state is considered an area of endemic *T. cruzi*, with seroprevalence rates up to 19 % in the general population.[18] Overall seroprevalence in the present study (0.7 %) was higher than that reported for blood donors in other parts of Mexico, such as Mexico City (0.37 %) or Veracruz state (0.48 %),[14,16] but lower than reported in others such as the states of Jalisco (1.28 %), Puebla (7.7 %) and Morelos (17 %).[9,15,19] Of the most routinely screened for serological markers (i.e. *T. cruzi*, HIV, HBV and HCV), the present data showed *T. cruzi* infection to be the most frequent, which coincides with other reports on blood donors in Mexico.[16,20,21] The apparently high male:female ratio observed here coincides with the higher frequency of male donors commonly reported in blood banks in Mexico.[14-16]

From 2002 to 2004, the anti-*T. cruzi* prevalence rate was higher among donors from rural areas (58 %) than among urban donors (42 %), whereas from 2005 through 2007 this rate was higher among urban donors (56.7 %); the latter rate is similar to that reported in Puebla state, a non-endemic area in Mexico.[9] The rural to urban shift in predominant seroprevalence may reflect a largely rural to urban migration pattern within Yucatan state. Indeed, the present results suggest that urban transmission rates are surpassing rural transmission rates, indicating a change in the typical scenario of *T. cruzi* transmission occurring mainly in rural areas. Anti-*T. cruzi* antibody prevalence by donor region of residence was heterogeneous, although Metropolitan area and Geographical Region 9 (South Yucatan) accounted for 73.6 % (*n* = 447) of all sero-positive donors (*n* = 607). This high prevalence is at least partially due to the presence of vectors. For example, a map of natural Chagas disease transmission risk based on pre-dictive models of *T. dimidiata* domestic abundance and *T. cruzi* infection rates by this insect vector on the Yucatan state[17] showed Geographical Region 6 to have a high pre-

Table III Seroprevalence of *Trypanosoma cruzi* antibodies in blood donors by geographic region in Yucatan state, México, from 2002 through 2007

Year	Geographic region								
	1	2	3	4	5	6	7	8	9
2002									
n	1	1	1	9	2	44	12	2	14
%	0.008	0.008	0.008	0.072	0.016	0.349	0.095	0.016	0.111
2003									
n	1	0	2	10	2	70	7	1	28
%	0.008	0	0.016	0.078	0.016	0.545	0.054	0.008	0.218
2004									
n	1	0	7	8	4	59	8	2	18
%	0.007	0	0.048	0.055	0.027	0.406	0.055	0.014	0.124
2005									
n	0	1	9	6	0	58	14	2	6
%	0	0.007	0.066	0.044	0	0.425	0.103	0.015	0.044
2006									
n	0	2	5	7	2	66	4	3	8
%	0	0.012	0.031	0.043	0.012	0.412	0.025	0.019	0.049
2007									
n	3	3	2	6	4	69	4	2	7
%	0.018	0.018	0.012	0.036	0.024	0.412	0.024	0.012	0.042
Total									
n	6	7	26	46	14	366	49	12	81
%	0.007	0.008	0.030	0.053	0.016	0.424	0.057	0.014	0.094

dicted transmission risk. Although the abundance of infected insect vectors is a direct indicator of natural transmission risk, additional factors may modulate transmission risk to humans, such as the presence and type of domestic animals.[22] In fact, the second most significant *T. cruzi* reservoir is the domestic dog, the infective strength of which makes it a relevant transmission factor in the domestic infection cycle.[23]

The higher anti-*T. cruzi* seroprevalence observed here in urban donors in recent years generally coincides with vector (*T. dimidiata*) and its reservoir (dog) frequency. In a recent study of anti-*T. cruzi* prevalence in dogs, made in the Merida urban area had a higher rate (14.4 %) than those sampled in a rural community in Yucatan (9.8 %).[24] In a separate study of *T. dimidiata* frequency in a number of neighbourhoods in Merida it was found that this vector is quite common, and that 38 % of the houses with *T. dimidiata* and 48 % of the collected triatomines tested positive for *T. cruzi.*[25]

Questionnaires are an important tool for screening donors at risk for different blood-borne diseases, including *T. cruzi.* However, none of the *T. cruzi* seropositive donors in the present study provided responses that identified them as potential carriers. This may be partially due to a lack of patient knowledge about the vectors and to specific statements about Chagas disease. The former could be addressed through programs promoting vector identification, understanding the disease and basic preventative measures such as fumigation, while the latter could be mitigated by improving questionnaire content. Both these measures would help to reduce the possibility of receiving blood units from potentially infected individuals who test negative for *T. cruzi* at the time of donation.

This study described the geographic distribution of anti-*T. cruzi* seropositive blood donors in Yucatan state, Mexico, from 2002 through 2007. When used in conjunction with information on vector distribution, this type of data can help health authorities to optimize the application of financial resources and better mitigate transmission of Chagas disease by focusing control and patient treatment programs in identified high-risk areas, thus reducing the probability of human carriers introducing it to low-risk areas.

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