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Chagas Disease Knowledge and Risk Behaviors of the Homeless Population in Houston, Texas

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Abstract

Chagas disease is a parasitic infection caused by *Trypanosoma cruzi* and endemic in Latin America. Sylvatic *T. cruzi* infected triatomine vectors are present in rural and urban areas in the southern United States and may transmit *T. cruzi* infection to at-risk populations, such as homeless individuals. Our study aimed to evaluate Chagas disease knowledge and behaviors potentially associated with transmission risk of Chagas disease among Houston, Texas' homeless population by performing interviews with 212 homeless individuals. The majority of the 212 surveyed homeless individuals were male (79%), African-American (43%), American-born individuals (96%). About 30% of individuals reported having seen triatomines in Houston, and 25% had evidence of blood-borne transmission risk (IV drug use and/or unregulated tattoos). The median total time homeless was significantly associated with recognition of the triatomine vector. Our survey responses indicate that homeless populations may exhibit potential risks for Chagas disease, due to increased vector exposure, and participation in blood-borne pathogen risk behaviors. Our findings warrant additional research to quantify the prevalence of Chagas disease among homeless populations.

Keywords

Chagas disease; *Trypanosoma cruzi*; Homeless; Texas; Vulnerable populations 92C60; 92D30

INTRODUCTION

Chagas disease, caused by *Trypanosoma cruzi* infection, is a neglected tropical disease endemic in the Americas that can cause chronic heart failure in up to 30% of those infected(1). This parasitic infection exists in both domestic and sylvatic transmission cycles,

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Compliance with ethical standards

Human subjects approval and waiver of written consent was granted from Emory University's Institutional Review Board (study number IRB00066083). All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Conflicts of interest

All authors declare that he/she have no conflicts of interest.

as essentially all mammalian species are competent reservoirs of disease(2, 3). Vector-borne transmission of *T. cruzi* via *Triatoma* insect species is the most common source of infection(4); however, transfusion of infectious blood, congenital, oral ingestion, and organ transplantation serve as other important transmission sources in endemic regions(5). Up to 8 million persons are infected worldwide, with the majority being unaware of their disease status due to a prolonged asymptomatic stage of disease(1). As a result of the high disease burden and lack of effective treatment in the chronic phase, cases of Chagas disease have a greater societal economic burden than malaria, rotavirus, and cervical cancer (6, 7).

A need exists to understand the risk of Chagas disease in the United States, particularly among potentially susceptible populations. An understudied likely at-risk population are homeless individuals. Homeless individuals inhabiting the southern United States might come into regular contact with *T. cruzi* infected vectors (8, 9). Twenty-seven contiguous southern states in the US have documented triatomine populations, and sixteen have documented sylvatic transmission to wildlife species(8). Texas, in particular, has a high triatomine species diversity, considerable sylvatic wildlife disease burdens, domestic animal cases, and the largest geographic cluster of autochthonous human cases in the US(10-13). Additionally, homeless subpopulations often engage in risky behaviors associated with transmission of pathogens through infected blood⁽¹⁴⁾, such as *T. cruzi*. Identification of risk factors in the United States is warranted given the ability to prevent advancing cardiac disease in asymptomatic, indeterminate patients and the subsequent economic savings (15, 16).

Given the growing body of evidence for disease transmission risk in Texas (11, 17), the Houston metropolitan was chosen to investigate the knowledge, behaviors and risk of Chagas disease to homeless populations. The objective of this study was to ascertain specific characteristics of homeless residents that might make them higher-risk for *T. cruzi* infection than the general public. The outcomes of this survey-based investigation will establish a foundation for future research targeting reduction of this disadvantaged population's Chagas disease risk.

METHODS

This study targeted the homeless population of the Houston metropolitan area. A convenience sampling of 212 homeless individuals in the Houston area were selected to participate through an encounter sampling methodology between June and August 2013. Human subjects approval and waiver of written consent was granted from Emory University's Institutional Review Board (study number IRB00066083).

Participants were identified through help from the Houston Police Department Homeless Outreach Team, and SEARCH Homeless Services Mobile Outreach Team. For this survey, the definition of 'currently homeless' included any individual living and sleeping outdoors or in an emergency shelter. Individuals were excluded from participation if the individual had a permanent address, a room in another person's home, or were living in veterans' single room occupancy apartments. The informed consent form and survey were administered verbally in English; therefore only individuals able to fluently communicate in

English were included. Adult participants (18+) were not excluded based on gender, ethnicity, or demographics; however, individuals that were unable to give informed consent due to mental illness or substance abuse were excluded from participating.

A quantitative survey instrument was developed based on six modules: demographic information, health history, knowledge about Chagas disease, travel history, daily activities, and regular behaviors. The main high-risk behaviors targeted were injection drug use, needle sharing, unregulated tattoos, sharing of tattoo equipment, time homeless, number of nights spent outside per week, and history of blood transfusion. The study instrument was developed based on discipline experts and refined by a pilot study comprised of homeless persons. Surveys were administered face-to-face, verbally, anonymously, and in less than ten minutes. Participation was voluntary and uncompensated. Refusal to participate did not impact the services provided by partnering organizations.

Data analysis was completed in SAS (Version 9.3). Continuous variables age, total length of time homeless, number of nights outdoors in the past week, and average number of nights slept outdoors per week were assessed for normality and considered non-normal; therefore, the median was the best descriptive statistic for these variables. To determine if there was a statistically significant difference between risk of Chagas disease among men and women, Chi square tests were conducted when appropriate (if expected cell count was less than five, Fisher's Exact Test was used). To determine if there was a statistically significant difference between males and females with continuous, non-normal variables, a Mann-Whitney-Wilcoxon test was performed.

RESULTS

Over six weeks (June 26-August 6, 2013) we encountered 463 homeless individuals and recruited 298 potential participants. From the 298 interested participants, a total of 212 participants met our study definition, were consented, and then enrolled into our study from 28 different locations in Houston, Texas (Figure I). The majority of participants (n=180) were recruited from a 3-mile square radius downtown urban area (n=20 sites); eight sites were located in suburban areas of Harris county, Texas. Of the 212 participants, more than three-fourths identified as male, and 12% self-identified as Hispanic ethnicity, with most respondents identified as either African American or Caucasian race (Table I). Variances in demographics did not statistically vary by study site, or by urban vs. suburban study site. Nearly all were born in the United States (96%), with the foreign-born participants originating from Cuba (n=3), Venezuela (n=1), and non-Latin American countries (n=4). Ages ranged from 21 to 75 years old. Our population was considerably older than the city (Houston median=34 years) and national (US median=38 years) population(18) with a study population median age of 49 years. A trend was noted that Hispanic participants were generally younger than non-Hispanic homeless participants. About half of surveyed respondents had health insurance; of those with insurance, approximately two-thirds had county-funded health coverage colloquially known as Harris County Gold Card (Table I). Regardless of insurance status, three-fourths (74%) used the local hospitals' Emergency Departments as their primary source of healthcare.

The range of total time homeless for all respondents was between 2 weeks and 1300 weeks (25 years). When asked how many nights one slept outside in the preceding week, males (~5 nights/week) spent significantly ($p<0.022$) more nights outside than females (~3 nights/week). The median total length of time homeless was greater for males [median 104 weeks (2 years)] than females [median 76 weeks (1.5 years)] surveyed, but not significantly different. Fifty-six percent ($n=119$) reported being consecutively homeless for the past year, which was considerably more for males (79% male, $n=95$). Seventy-two percent of homeless participants recruited from suburban sites were consecutively homeless (1+ year), compared to 53% recruited from urban sites. Suburban participants had 2.23 greater odds of consecutive homelessness compared to urban participants ($p<0.0515$); however, power calculations were suboptimal (power=0.1621) warranting further investigation in a larger population. Lastly, 43% ($n=92$) had ever lived or traveled outside the US, including travel to more than one country. Latin American country travel histories included: México (60), Venezuela (4), Cuba (4), Guatemala (4), Argentina (3), Colombia (3), Brazil (3), Belize (2), Ecuador (2), Perú (2), Panamá (2), Honduras (1), Costa Rica (1), Nicaragua (1), Bolivia (1), and El Salvador (1).

We assessed knowledge about Chagas disease among the homeless population in the second module of the survey. Only 7 individuals (3%) had ever heard of Chagas disease (Table II). Those having heard of Chagas disease had either previous employment in the medical field or had emigrated from an endemic country. Although many had not heard of Chagas disease, 30% of participants recognized a picture of the triatomine, and 2% of individuals reported having been bitten by the triatomine in Houston. An additional 10% of participants were unsure if they had been bitten. The percentages of respondents who had heard of Chagas disease, recognized the triatomine picture, or believed to have ever been bitten was similar between males and females. Length of time homeless was significantly associated ($p<0.004$) with those who recognized the vector (4 years) compared to those who did not recognize the vector (1.5 year) (Figure II). Of those that recognized the triatomine vector in the Houston city area, the majority reported seeing the triatomine vector in a park ($n=41$, 64%), followed by an associate's house ($n=9$, 14%), a homeless shelter ($n=3$, 5%), or don't know/other ($n=11$, 17%).

To explore risky behaviors potentially associated with blood-borne *T. cruzi* transmission, we asked respondents about certain practices, such as injection drug use and unregulated tattoos. As seen in Table II, 28% ($n=60$) of respondents had ever used needles to inject drugs, and approximately half of these individuals ($n=32$) had shared needles. Of those participants that reported using IV drugs, most used on a daily ($n=42$, 70%) or weekly ($n=10$, 17%) basis. Of the participants that reported using IV drugs, needle sharing was rare ($n=15$, 47%), often ($n=10$, 31%), or occasional ($n=7$, 22%). About 44% of all respondents received unregulated tattoos (not in a licensed shop); with prison ($n=53$, 57%), residential setting ($n=36$, 39%), or other locations ($n=4$, 4%) serving as sites of tattoo acquisition. Five individuals recalled sharing tattoo equipment such as needles or ink in the process. Participation in IV drug and tattoo activities were not statistically different between genders. Lastly, 7% ($n=14$) had a history of blood transfusion prior to 2007, when the screening of blood products for *T. cruzi* infection became nationally implemented.

DISCUSSION

The goal of this research was to assess the risk of Chagas disease among Houston's homeless population by participation in a guided questionnaire. We identified vector-borne and blood-borne transmission risks present among the homeless population in Houston, Texas. Vector-borne transmission risks included nights slept outside (the time of peak vector activity), long durations of time having been homeless, recognition of the vector, and travel to endemic Latin American countries. Blood-borne transmission risks included high use of intravenous drugs and unregulated tattoos; however, these risks are potentially minimized as indicated by a reported low frequency of sharing drug and tattoo needles. Both types of transmission risk are likely exacerbated among this population, potentially placing them at risk for behaviors that encourage vector and infectious blood exposures.

One-third of our homeless residents reported recognition of the triatomine vector during their time outside in the metropolitan area, most often in city parks. While there is a chance for recall bias, vector recognition is supported by our laboratory's collection of the vector in an ongoing surveillance project of triatomines in collaboration with Harris County Public Health Mosquito and Vector Control (unpublished data). Furthermore, over half of our homeless population had been homeless for the past year or more, spending five or more nights outside. Homeless populations are exposed to a number of vectors that may transmit disease and fall victim to a heavy burden of diseases transmitted by louse, fleas, ticks, flies, and arthropods (9, 19, 20). Vector exposure is a real concern for our homeless population, and with *Triatoma* vectors being present in 27 contiguous states (8), there is a likely chance that homeless persons across the United States spending the night outdoors during peak vector feeding times are at-risk for vector-borne disease.

Our research identified that nearly three-fourths of homeless individuals used the Emergency Department as their primary location of healthcare services, despite the majority having health insurance. Most homeless individuals do not receive preventative or continuous care and often need immediate medical attention (21). Excluding obesity and stroke, homeless individuals are more likely to suffer from chronic illness like HIV, diabetes, and heart conditions than the general public(22, 23). With cardiac manifestations being the primary health outcome of concern with chronic Chagas disease(24), homeless persons might be more susceptible to cardiac manifestations than the general public due to high rates of immunocompromising health conditions among this population(25). Physician knowledge of Chagas disease is low in the United States (26, 27), and targeting emergency room physicians should be a priority to ensure homeless populations are screened for infection as well as the chronic cardiac manifestations of Chagas disease.

Homeless persons in Houston regularly exhibited practices known to be hazards for blood-borne pathogen transmission. Intravenous drug use (28%) and unregulated tattoos (44%) were commonly reported among our homeless participants; however, the use of shared needles for drug injection (53%) was higher than the use of unregulated tattoo (5%) suggesting that IV drug use might be a greater concern for blood-borne transmission. With up to 77% of chronic Chagas patients testing positive on qPCR for parasitic DNA(28), the opportunity for lifelong infectious blood transmission exists. The risk of blood-borne

transmission of *T. cruzi* via sharing of needles has never been quantified and warrants further investigation.

The high incidence of diseases from insects is associated with high poverty, poor sanitation, close quarters, and exposure to the elements(9, 20). Our study found that the risk of Chagas disease among homeless in Houston, Texas is a real concern. Wooded areas, parks, and county benches are common areas for homeless individuals to congregate and sleep during the night and are common areas for vectors. Conversations with experts of the Houston Police Department's Homeless Outreach Team and independent homeless outreach organizations identified that, anecdotally through their work, drug and alcohol abuse confounded the risk of exposure to bugs because individuals who are incapacitated and sleeping outdoors are less likely to realize that bugs are biting them while sleeping. These individuals are more likely to complain of chigger bites, bed bugs, mosquitoes, etc. By this logic, the same could be applied to triatomines; males in our study were more likely to sleep outdoors and had a higher rate IV drug usage, so these individuals may be less likely to protect themselves against bites from bugs, including the triatomine. Any homeless individual spending the majority of nights per week sleeping outdoors and has an extended total length of nights spent outdoors (ie 1.5+ years) likely has an increased amount of contact time with triatomines and are potentially at an increased risk of contracting Chagas disease.

Limitations of this study include the non-random or systematic recruitment of respondents to participate in the survey. Individuals were approached and asked to participate when encountered by the SEARCH Homeless Services Outreach Team or Houston Police Department Homeless Outreach Team and a member of our research team. These individuals were mostly encountered in encampments, near highway underpasses, in parks, or at a facility offering day services such as laundry, meals, and employment training. Those who seek day services may be systematically different than those who do not in regards to health status, mobility levels, education, etc. Similarly, respondents were more likely to decline participation when approached during rush hour times, such as the morning or evening commutes, because this was often time for panhandling and peak income generation. Those individuals who were able to panhandle and had been on the streets longer may systematically differ from those who chose to participate. Unfortunately, no incentives were given for participation except for cold waters that were given to all who were approached; those who participated may have been more willing to provide their time and answers than others. Lastly, the potential for recall bias exists which could limit the precision of our data analysis. Our current study was a hypothesis-driven pilot study and further efforts to refine the validity of our risk findings are underway.

Despite the limitations for data collection, certain strengths such as the short length of the survey, about 10 minutes, may have captured individuals who would not have otherwise been willing to participate in the survey. The data collection was completely anonymous and confidential, even in the presence of the Houston Police Department Homeless Outreach Team who helped to recruit participants, which may have encouraged individuals to participate, especially those engaging in risk behaviors such as injection drug use, who

otherwise would not have considered participating. The anonymity may have also positively affected the accuracy of answers provided by respondents.

Based on these findings, the Houston-area homeless population could be at risk for Chagas disease based on the length of time homeless and nights sleeping outside as well as high-risk behaviors for spreading pathogens in the blood such as injection drug use and unregulated tattoos. This information could inform future research as well as educational programming about Chagas disease aimed at both the homeless population and healthcare providers. Shelters and emergency room staff should be educated on how they can instruct homeless individuals to reduce their risk-behaviors related to Chagas disease. It is essential for the homeless population to understand how one can become infected, either through the bite of the triatomine or the sharing of blood products by needles. Lastly, our findings indicate that further studies evaluating the disease burden of Chagas disease among homeless persons in the southern United States is warranted.

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Figure 1.
Geographic locations of the 28 study recruitment sites in Houston, Harris County, Texas

Figure II.

Total time homeless was significantly associated ($p < 0.004$) with recognition of the Triatomine vector in Houston, Harris County, Texas

Table 1.

Demographics of Surveyed Homeless Individuals in Houston, TX 2013 (N =212).

		Ethnicity	
Variable		Hispanic	Non-Hispanic
	No. (% ¹)	No. (% ²)	No. (% ³)
Age at Time of Interview			
<i>21-30 years old</i>	27 (12.8)	5 (20.0)	22 (11.8)
<i>31-40 years old</i>	34 (16.1)	6 (24.0)	28 (15.0)
<i>41-50 years old</i>	60 (28.4)	5 (20.0)	55 (29.4)
<i>51-60 years old</i>	71 (33.6)	4 (16.0)	67 (35.8)
<i>61-70 years old</i>	17 (8.1)	3 (12.0)	14 (7.5)
<i>71-80 years old</i>	2 (0.9)	1 (4.0)	1 (0.5)
Male Sex	168 (79.0)	18 (72.0)	150 (80.2)
Race			
<i>African American</i>	92 (43.4)	1 (4.0)	91 (48.7)
<i>Caucasian</i>	87 (41.0)	1 (4.0)	86 (46.0)
<i>Other</i>	20 (9.4)	18 (72.0)	2 (1.1)
<i>Mixed</i>	7 (3.3)	4 (16.0)	3 (1.6)
<i>American Indian</i>	6 (2.8)	1 (4.0)	5 (2.7)
<i>Asian</i>	0 (0.0)	0 (0.0)	0 (0.0)
Born in the United States	204 (96.2)	21 (84.0)	183 (97.9)
Has Health Insurance	124 (58.5)	18 (72.0)	106 (56.7)
Insurance Type			
<i>Harris County Gold Card</i>	75 (61.5)	10 (40.0)	65 (34.8)
<i>Medicaid</i>	20 (16.4)	1 (4.0)	19 (10.2)
<i>Medicare</i>	10 (8.2)	2 (8.0)	8 (4.3)
<i>Veteran's Benefits</i>	9 (7.4)	1 (4.0)	8 (4.3)
<i>Other</i>	8 (6.6)	4 (16.0)	4 (2.1)
Healthcare Site			
<i>Emergency Room</i>	157 (74.1)	17 (68.0)	140 (74.9)
<i>Clinic</i>	35 (16.5)	6 (24.0)	29 (15.5)
<i>Doesn't Seek Healthcare</i>	11 (5.2)	1 (4.0)	10 (5.3)
<i>Private Physician</i>	8 (3.8)	0 (0.0)	8 (4.3)

		Ethnicity	
Variable		Hispanic	Non-Hispanic
	No. (% ¹)	No. (% ²)	No. (% ³)
<i>Pharmacy</i>	1 (0.5)	1 (4.0)	0 (0)

¹Denominator is total number of participants (n=212)

²Denominator is total number of participants (n=25)

³Denominator is total number of Non-Hispanic participants (n=187)

Table 2.

Selected Variables of the Chagas Disease Knowledge and Risk Behaviors Survey among Homeless Individuals in Houston, TX 2013 (N = 212).

Variable [^]	YES	NO	Don't Know
	no. (%)	no. (%)	no. (%)
Heard of Chagas Disease	7 (3.3)	203 (95.8)	2 (0.9)
Recognize Triatomine Picture ¹	64 (30.5)	137 (65.2)	9 (4.3)
Believed to Have Been Bitten ²	5 (2.4)	183 (88.0)	20 (9.6)
Used Needles to Inject Drugs ³	60 (28.3)	151 (71.2)	1 (0.5)
Shared Needles	32 (53.3)	26 (43.3)	2 (3.4)
Unregulated Tattoo(s)	93 (43.9)	119 (56.1)	0 (0.0)
Shared Tattoo Equipment ⁴	5 (5.4)	73 (78.5)	15 (16.1)

¹Two individuals did not answer this question.

²Four individuals did not answer this question.

³One participant refused to answer question about ever using needles to inject drugs

⁴All 93 who indicated receiving an unregulated tattoo also answered question about sharing of needles

[^]All percentages are row percentage