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INVESTIGATION / RESEARCH

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**Current prevalence and risk factors related to Chagas disease in Bolivia**

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**ABSTRACT**

Chagas disease (CD) caused by *Trypanosoma cruzi*, is a major health problem in Bolivia. In this study, we have assessed the prevalence and the risk of infection by *T. cruzi* in nine Bolivian departments. The overall average seroprevalence was 19.5% (2-32%) being higher in women between 11-20 years old. The *T. cruzi* genetic lineages infecting humans was 43.4% TcI; 45.4% TcV, 8.5% TcII and 2.7% for TcV and TcII. *T. cruzi* infection was detected in 49.1% of the 1,671 *Triatoma infestans* captured within houses, the majority (65%) made of bricks. Among these, 39.5% were TcI, 52.1% TcV, and 8.4% TcII. The assessment on the knowledge about the disease and the etiological agent revealed that 57% of teachers and health workers are aware of the parasite and 64% of the students receive information about CD, among which, 82% were able to recognize triatomines.

**Keywords:** Chagas disease, American trypanosomiasis, Epidemiology, *Triatoma infestans*, *Trypanosoma cruzi*.

**INTRODUCTION**

Chagas disease (CD), named after Carlos Chagas, who first described the parasite and the disease in 1909, is caused by the hemoflagellate parasite, *Trypanosoma cruzi*, that infects more than six million people worldwide<sup>1</sup>, especially in the Southern Cone of South America<sup>2</sup>. Chagas disease remains a major health problem in the Southern Cone of South America, especially in Bolivia<sup>2</sup>. Distinct studies carried out in different endemic areas of Bolivia indicates infection rates varying from 26.0% to 71.0% in children between 1 to 6 years old and from 32.0% to 93.5% in adults [9,10]. In 2008, Bolivia's National Chagas Program started a pilot program of treatment of infected adults in Cochabamba, Tarija and Potosi Departments<sup>3</sup> along with a Chagas disease control program based on insecticide spraying of human domiciles targeting the control of *Triatoma infestans*, the most prevalent and wide dispersed vector in Bolivia<sup>4</sup>. CD in Bolivia is mainly due to vectorial transmission by triatomine bugs, locally known as “vinchuca”<sup>3</sup>, affecting primarily the humble people<sup>4</sup>. The houses built with precarious materials, such as adobe, mud or straw, allows domiciliation of the vector and increases the risk of contracting the disease<sup>5</sup>. The main CD infection routes are via contact of mucous or wounded skin with the feces of the infected triatomine, blood transfusion, organ transplant, congenital transmission, laboratory accident and oral ingestion<sup>4</sup>. The Chagas disease presents two clinically distinct phases: the acute and the chronic. An initial acute phase with highly variable symptoms, from which most of the infected patients recover to an apparently healthy state, in which no organ damage can be detected using the current standard methods of clinical diagnosis. Thus, diagnosis of the infection can only be verified by parasitological or indirect serological or tests. The acute phase is followed by an asymptomatic indeterminate phase, which can be life-long. Years or even decades after the initial infection, around 30% of infected patients might progress to asymptomatic chronic phase<sup>7</sup>. Depending on various factors such as the geographical area, the parasite genetic background and the patient's immune response, irreversible lesions of the autonomous nervous system in the heart, esophagus and colon, and of the peripheral nervous system which is usually characterized by cardiomyopathy, although gastrointestinal complications including megaesophagus and megacolon might occur. *T. cruzi* strains are highly genetically diverse taxon and the understanding of the population structure of this parasite is critical due to the links of the distinct transmission cycles and disease. Nowadays, *T. cruzi* is partitioned into six discrete typing units (DTU) named TcI to TcVI<sup>8</sup> and such genetic variability must be taken into account on diagnosis and clinical management of the infected patients. Despite major efforts on the control of transmission of CD, the participation of the local community is fundamental for actions towards the reduction of transmission and prevalence. In this sense, continued efforts on public health education and assessment of the effectiveness of such actions are also of major relevance for the control of CD.

In this work, we addressed the seroprevalence of Chagas disease in nine departments of Bolivia after the national efforts for vector control. Risk factors such as the type of construction of the seropositive patient's domiciles, the presence of the triatomines within houses and other human dwellings, the knowledge about Chagas disease of the people in this endemic area were evaluated. Also, we have performed the molecular typing of the *T. cruzi* isolates obtained via xenodiagnosis from infected patients and from triatomines collected from within these. In the present study, the efficacy of the *T. infestans* control program was assessed using a comprehensive diagnosis survey carried out in nine Bolivian departments.

## METHODS

Written informed consent was obtained from all participants following approval by the Hospital Albina R. de Patiño ethics committee. A questionnaire evaluating the knowledge concerning Chagas disease was applied to school teachers, students, and healthcare workers in the nine departments of Bolivia. Blood samples (5 mL) was collected from 4,620 participants (55.7% male, 44.3% female) and assayed for Chagas disease using HAI and ELISA. Xenodiagnosis was performed in all seropositive patients and search for triatomines have been in the houses of seropositive and seronegatives individuals. Triatomine infection was assessed by fresh examination of feces samples obtained by abdominal compression of live triatomines. Parasite isolation was performed by xenoculture and molecular characterization was carried out by PCR as described elsewhere. All participants received confidential individual results and all positive patients were treated under the auspices and supervision of the Bolivian Health Ministry.

## RESULTS

A total of 4,620 individuals aging between 5 to 60 years were screened. Seroprevalence among the districts varied from 2% to 32% with an average of 19.5% with a higher proportion in women between 11 to 20 years old. Xenodiagnosis positive for 98.9% of the seropositive patients, that were treated with Benznidazole according to the Bolivian Health Ministry recommendations. Molecular characterization of *T. cruzi* isolated by xenodiagnosis revealed that 43.4% belong to TcI; 45.4% to TcV and 8.5% to TcII and 2.7% presented mixed TcV and TcII infection. From the 1,671 *T. infestans* captured inside houses 49.1%, revealed positive for *T. cruzi* infection by fresh feces examination. *T. cruzi* TcI was identified in 39.5%; TcV in 52.1% and TcII in 8.4% of these samples. The

majority of the investigated houses (65.0%) were made of brick, 12.0% of adobe and 23.0% were mixed (adobe + brick). Around 38.0% of the schoolteachers and 31.0% of the healthcare professionals pointed out that transmission of CD occurs via triatomine bugs (vinchuca) while 57.0% of these professionals have correctly indicated that *T. cruzi* is the causative agent of Chagas disease. Among the students, 64.0% recognized to receive information about Chagas disease either at school or at home and 82.0% of them were able to recognize triatomines.

## DISCUSSION

The present work revealed a *T. cruzi* mean seroprevalence of 19.5% in the nine districts of Bolivia after implementation of vector control campaign. Although indicating an apparent reduction of the parasite transmission when compared to former seroprevalence studies, the prevalence variability between departments and the higher frequency of infection between young women (11 to 20 years old) seems to indicate an active and intra domiciliary transmission of CD in the country. The implementation of the vector control program along the educational efforts targeting the control of CD seems to be effective and efforts to maintain such measures would help to reduce the parasite transmission over time. The major *T. cruzi* DTUs circulating in Bolivia between humans and triatomines are TcI, TcV, and TcII, also indicating that active transmission occurs by domiciliated triatomines harbouring *T. cruzi* DTUs related to the sylvatic environment. Although seroprevalence seems to indicate a reduction of the transmission of CD, the number of *T. cruzi*-infected triatomines within brick than in adobe-made houses clearly indicates the needs for improving housing and control measures. Based on our results, we can indicate that around 58,9 % of the country is of the high risk of infection by *T. cruzi*, while 39.7% is of moderate to low risk.

## CONCLUSION

Our results seem to indicate a reduction of the Chagas disease prevalence to 19.5% in the studied districts since the implementation of the Chagas disease control program in Bolivia, but also pointed-out that intra domiciliary transmission of CD by triatomine vectors is still high and that infection is due to distinct *T. cruzi* DTUs. Also, our results reinforce the importance of continuing triatomine control and educational campaigns towards interruption of *T. cruzi* transmission in the country.

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