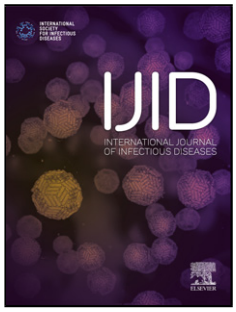

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Chagas Disease in the Bolivian Chaco – persistent transmission indicated by childhood seroscreening study

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Highlights

- *T.cruz*i infection is endemic in the Bolivian Chaco
- Childhood *T.cruzi* seroprevalence was 0.22, rising steeply with age
- Persistent transmission persists shown by FOI annual incidence estimate of 0.021
- School-based screening with rapid tests is a practical approach in remote areas
- Current intermittent vector control practises in the Bolivian Chaco are suboptimal

Abstract

Background

We screened for *Trypanosoma cruzi* infection amongst children in a rural community in the Bolivian Chaco, an area known for high prevalence. We also estimated the force of infection (FOI).

Methods

423 children were screened using InBios (Seattle, WA) *ChagasDetectPlus (CDP)* rapid test at the local school. CDP-positive specimens were further tested by indirect hemagglutination assay (IHA) and Wiener Recombinante v3.0 ELISA. A catalytic model was used to estimate FOI.

Results

Confirmed seroprevalence was 0.22, rising steeply with age. The mean age of seropositive individuals was 13 years. Rapid test specificity was calculated 91.9%, the annual incidence estimated from the FOI was 0.021.

Conclusion

This study demonstrates persistent transmission and continued high levels of *T.cruzi* infection in the Bolivian Chaco, and highlights the practicality of school-based screening.

Keywords: Chagas; Trypanosoma cruzi; Bolivian Chaco

Introduction

The semi-arid lowland of the Gran Chaco spanning parts of Bolivia, Paraguay and Argentina is reported to have the highest prevalence of *T.cruzi* infection in the world, due to well documented local challenges in triatomine vector control and surveillance (Gurtler, 2009, World Health Organisation, 2015) Chronic infection with *T. cruzi*, the aetiological agent of Chagas disease, leads to clinically significant cardiovascular and gastrointestinal disease in an estimated 30-40% of cases, and treatment remains challenging (Perez-Molina and Molina, 2018). Untreated, infection persists lifelong, and thus prevalence increases with age, reflecting cumulative incidence. Children are often tested as a sentinel population for recent transmission, with effective vector control rapidly decreasing seroprevalence in this subpopulation. Despite this, published childhood seroprevalence data from the Bolivian Chaco are limited; to date, few seroscreening studies have been published, with the most recent reporting a seroprevalence of 19.8% (Samuels et al., 2013). Here, we report the results of a recent screening study, demonstrating persistent high levels of infection indicating sustained vector transmission.

Methods

Screening

At the request of the local authorities, we screened school-age children in July to August 2017 in a village near Camiri, the capital of Cordillera province in the Bolivian Chaco. All children attending the local primary and secondary schools were eligible to participate, with no age restriction. The child's parent or guardian provided written informed consent, and verbal assent

was obtained from the child. Children were screened using the ChagasDetectPlus (CDP) immunochromatographic assay (InBios, Seattle, WA), previously shown to have 96.2% sensitivity and 98.8% specificity in a similar population in the Bolivian Chaco (Shah et al., 2014). Children with positive CDP results had venous blood drawn and tested by the indirect haemagglutination assay (IHA; Chagas Polychaco kit; Lemos Laboratories, Buenos Aires, Argentina) following national Chagas disease control protocols. Discordant specimens were further tested by Wiener Recombinante v3 ELISA.

Seropositive individuals were offered benznidazole treatment in accordance with local governmental protocols. The houses of infected children were sprayed by the local control program before commencement of treatment.

Analysis

Descriptive statistics were generated using IBM SPSS v24. The force of infection (FOI) was calculated using a catalytic model applied to age-prevalence data (Courtenay et al., 1994).

Ethical approval was granted by The University of Warwick's Biomedical & Scientific Research Ethics Committee (BSREC) Committee.

Results

A total of 424 children were eligible for screening, and 423 were tested by CDP in capillary fingerstick blood. The mean age of tested children was 11 (SD 4.4, range 4-21); 49.1% were male. CDP results were positive for 122 individuals. One child with positive CDP refused IHA testing. One child reported a previous positive result by IHA but tested negative by CDP, and was included in IHA testing. Of 121 children tested by IHA, 94 had positive results: 93 with positive CDP results plus the previously IHA-positive CDP-negative student. The 29 sera with discordant results were all negative by ELISA. These results correspond to CDP specificity of 91.9% (exact 95% confidence interval 88.6 – 94.5). The final seroprevalence was 0.22 (95% CI=18.4-26.2; 93/422, excluding the unconfirmed positive CDP result from the analysis).

The mean age of seropositive individuals was 13 (SD 3.9, range 5-21); 47.3% were male. As expected, prevalence increased steeply with age.

The age-prevalence increased with age with no apparent recovery, as shown in Figure 1. The annual incidence estimated from the FOI was 0.021 (95% CI=0.0128-0.0294).

Discussion

The observed seroprevalence is similar to that previously described by Samuels et al in 2013 (age < 16 = 18.9% and 19.8% respectively) in a nearby municipality. This, coupled with the high FOI estimate, demonstrates significant recent vector transmission. Although the ChagasDetectPlus specificity (91.9%) in this study was lower than in previous analyses, screening in this rural village was greatly facilitated by the use of this rapid test (Eguez et al., 2017, Shah et al., 2014). Pairing a highly sensitive rapid test with a more specific confirmatory test allows efficient screening, even in a challenging community setting. Practicality was further enhanced by our school-based screening model, which provided an accurate record of potential participants without reliance on census data, and facilitated timely testing.

Poor treatment compliance with the 60-day treatment course and frequent adverse drug reactions have made screen-and-treat programmes hard to justify in a healthcare system with limited resources. Recent results from the BENDITA Phase II trial (Drugs for Neglected Diseases Initiative, 2019) suggest that shorter courses of benznidazole may provide equivalent parasitological efficacy to the current 60-day standard course. If Phase III trials confirm these results, large scale paediatric screen-and-treat programmes may become feasible in resource poor settings. We advocate school-based screening with rapid tests as a practical way to achieve this, at least in areas such as the study community where school attendance is high. In communities where a significant proportion of children do not attend school, school-based designs may miss high risk children.

Our results add weight to the current consensus that significant vector transmission persists, and that the current intermittent vector control practises in the Bolivian Chaco are suboptimal, but critical to improve.

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Conflict of Interest

The authors have no conflicts of interest to declare.

Author Contributions

CB and OC designed the study protocol; TH, RG and JM conducted the field work; TH drafted the manuscript; all authors read and approved the final manuscript.

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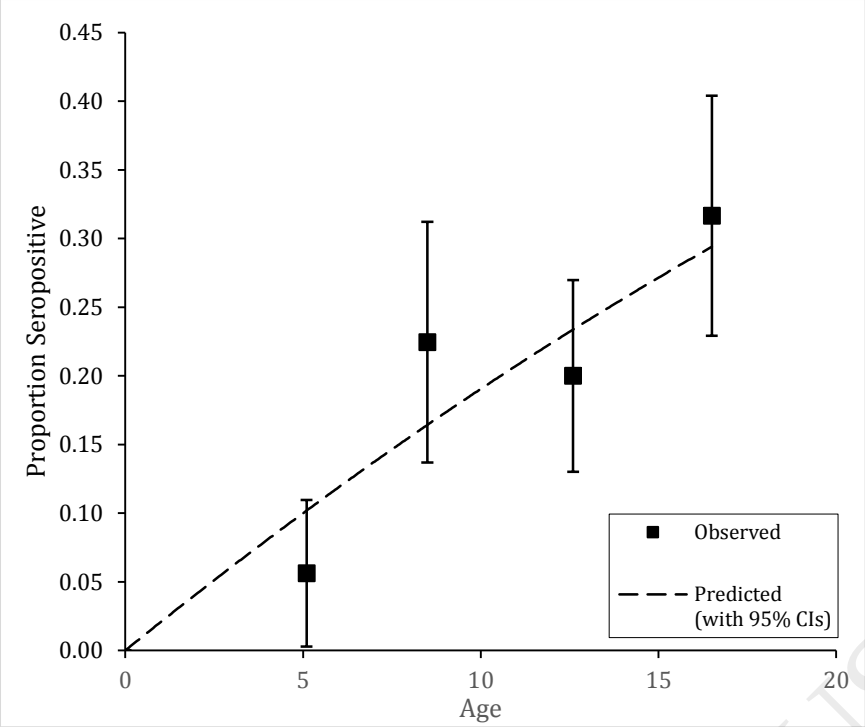

Figure 1 – Comparison of FOI catalytic model and observed seroprevalence

Table 1 – Comparison of seropositive and seronegative individuals by age range

Age group	**Total tested**	**Positive (%)**
4-6	89	5 (5.6)
7-10	98	22 (22.4)
11-14	115	28 (24.3)
15+	120	38 (31.7)
Total	422	93 (22.0)