Short Communication

# Chagas disease in the Bolivian Chaco: Persistent transmission indicated by childhood seroscreening study

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ABSTRACT

Background: Screening for Trypanosoma cruzi infection was performed amongst children in a rural community in the Bolivian Chaco, an area known for high prevalence. The force of infection (FOI) was estimated.
Methods: A total of 423 children attending the local school were screened using the Chagas Detect Plus (CDP) rapid test (InBios International, Inc.). CDP-positive specimens were further tested by indirect haemagglutination 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. The calculated specificity of the rapid test was 91.9%. The annual incidence estimated from the FOI was 0.021.
Conclusions: This study demonstrates persistent transmission and continuing high levels of T. cruzi infection in the Bolivian Chaco, and highlights the practicality of school-based screening.

## Introduction

The semi-arid lowland of the Gran Chaco, spanning parts of Bolivia, Paraguay, and Argentina, is reported to have the highest prevalence of Trypanosoma 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, the 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). The results of a recent screening study are reported here, demonstrating persistent high levels of infection, indicating sustained vector transmission.

## Methods

### Screening

At the request of the local authorities, screening of school-age children was performed during July and 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 in the screening, with no age restriction. Each child's parent or guardian provided written informed consent, and verbal assent was obtained from the child. Children were screened using the Chagas Detect Plus (CDP) immunochromatographic assay (InBios International, Inc., Seattle, WA, USA). This assay has previously been shown to have sensitivity of 96.2% and specificity of 98.8% in a similar population in the Bolivian Chaco (Shah et al., 2014). Children with positive CDP results had venous blood drawn and tested by indirect

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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 v3.0 ELISA.

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

### Analysis

Descriptive statistics were generated using IBM SPSS Statistics version 24.0 (IBM Corp., Armonk, NY, USA). 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 Biomedical and Scientific Research Ethics Committee (BSREC) of the University of Warwick.

### Results

A total of 424 children were eligible for screening, and 423 were tested by CDP using capillary fingerstick blood. The mean age of the tested children was $11 \pm 4.4$ years (range 4–21 years); 49.1% were male. CDP results were positive for 122 individuals. One child with a positive CDP result refused IHA testing. One child reported a previous positive result by IHA but tested negative by CDP and was included in IHA testing. Of the 121 children tested by IHA, 94 had a positive result: 93 with a positive CDP result 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 (CI) 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 $13 \pm 3.9$ years (range 5–21 years); 47.3% were male. As expected, prevalence increased steeply with age (Table 1).

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 described previously by Samuels et al. in 2013 in a nearby municipality (age <16 years = 18.9% and 19.8%, respectively). This, coupled with the high FOI estimate, demonstrates significant recent vector transmission. Although the specificity of the CDP (91.9%) in this study was lower than that reported 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 the school-based screening model used, which provided an accurate record of potential participants without reliance on census data, and facilitated timely testing.

**Table 1**
Comparison of seropositive and seronegative individuals by age range.

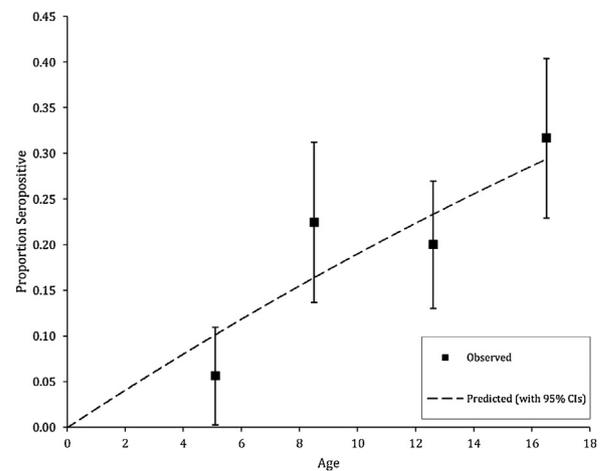| Age group (years) | Total tested | Positive (%) |
| --- | --- | --- |
| 4–6 | 89 | 5 (5.6) |
| 7–10 | 98 | 22 (22.4) |
| 11–14 | 115 | 28 (24.3) |
| 15+ | 120 | 38 (31.7) |
| Total | 422 | 93 (22.0) |



**Figure 1.** Comparison of the FOI catalytic model and observed seroprevalence.

Poor treatment compliance with the 60-day treatment course and frequent adverse drug reactions have made screen-and-treat programmes difficult 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 communities such as the one investigated in the present study, 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.

The study 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

No conflict 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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