The ecological and social dimensions of Chagas disease risk in rural communities of the Argentine Chaco.

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Roadmap

Quick overview of Chagas

Chagas disease in Gran Chaco

How can we combine the social and ecological dimensions

Our findings in rural indigenous communities
Chagas disease in Latin America: a quick overview

- Caused by *Trypanosoma cruzi*

- **Transmission routes:**
  - Vector-borne (Triatominae bugs)
  - Vertical transmission
  - Blood transfusion / organ transplant
  - Oral transmission by consumption of contaminated food

The kissing bug bites and gets infected. The parasite Trypanosoma cruzi replicates within the kissing bug. The kissing bug defecates, and the person gets infected. ~30% develop the disease, and ~10% mortality. Acute phase: Romagna sign (~5%) Flu-like symptoms. Chronic phase: ~30% develop the disease, ~10% mortality.
Chagas disease: a neglected tropical disease

- They affect vulnerable populations
- They are not rare diseases
- The present a focal distribution → “INVISIBILE disease”
- Preclude sustainable development of affected communities

Social stratification
- Social strata
- Gender
- Ethnicity

- Differences in exposure
- Different consequences of exposure
- Different ability to recover

Health inequalities
Gran Chaco región: one of 10 global hotspots for NTDs

Gran Chaco region:
- Sparse rural villages and a few urban centers
- Subsistence economy
- High levels of poverty
- Substandard housing
60% of infected people in Latin America live in Argentina and Bolivia (WHO, 2015)


The Southern Cone Initiative (WHO/PAHO, 1990)

Achievements:
- Large reduction in the geographic range of T. infestans.
- Interruption of intra-domiciliary vectorial transmission in Brazil, Chile, Uruguay and, in 2018, in Paraguay.

Remaining challenges:
- T. cruzi infection remains high (27.8 – 71.1%)
- Scarce resources available towards vector control activities
- Competing priorities, i.e. mosquito-borne diseases.
- Highly focal distribution and hidden hot spots
- Insecticide resistance in the vector
- Economic instabilities in the region
- “the punishment of success”: when political interest (and resources) decline after transmission has been controlled
- Low access to health services
Vector ecology: what does T. infestans need?

Refuge for the vector

T. Infestans are associated with poor house quality and unplastered walls.

Blood meals for the vector

Hosts:
- Humans
- Dogs
- Cats
- Poultry
- Livestock

Refuge for the vector

Storing quarters for sleeping quarters and livestock animals.
What affects the transmission of T. cruzi to humans?

- Socio-economic factors
- Cultural and political factors
- Ecological factors
- Biological factors

- Ecohealth approach (IDRC, Canada)
- Eco-bio-social approach (TDR/WHO)

- How many?
- How they interact?
- What is the immune response?
- What is the infectivity?
Understanding the eco-bio-social determinants to find high risk areas of human infection: the case of Pampa del Indio, Chaco
Demography of Pampa del Indio

- ~2000 people
- 10% Creole
- 90% Qom

- 44% <15 years old
- 4% >60 years old
Socio-historical context

1909-1912
First creole settlements in Pampa del Indio

1911-1914
Militar campaigns and creation of “reducciones aborígenes” (concentration camps) (e.g. Napalpi)
Socio-historical context

Ingenio Las Palmas (Sugar plantation)

- 1930: Smallpox epidemic among the Qom people in Pampa del Indio
- 1924: Massacre of Napalpi
- 1932: The Argentine state gave the Qom people precarious land titles in Pampa del Indio
- 1947: Pampa del Indio was officially funded
- 1951: Chaco became a province of the Argentine State
- 1950: Socio-historical context
Socio-historical context

Ingenio Las Palmas (Sugar plantation)

1962: National vector control program begins
1970: Decline in economic activity starts, cotton activity increases
1990: Migration to urban centers
1995: First health program for indigenous communities
Current social context

- Structural poverty

- Household income sources:
  - Subsistence livestock farming
  - Informal temporary employment
  - Welfare
The eco-bio-social determinants of Chagas disease risk
What is the interaction between the social and ecological factors that determine the abundance of infected vectors?
How do we measure socio-economic status in these settings?

Socio-economic and political context
- Governance
- Macroeconomic policies
- Social policies (i.e. welfare, housing, etc.)
- Public policies (i.e. health, education, etc.)

Structural determinants

Individual and household level
- Socio-economic position
  - Educational level
  - Income
  - Economic stability

Intermediary determinants
- Material circumstances (e.g. housing quality, assets, etc.)
- Behaviors (e.g. mobility and migration)
- Access to the healthcare system

Material circumstances
- Health outcome

Social vulnerability index
- Means of transportation
  - TV
  - Fridge
  - Freezer
  - Radio
  - Cell phone

Asset index

Housing construction materials
- Overcrowding
- Educational climate
- Goat-equivalent index (livestock)
- Welfare (monetary income)
- Informal work (monetary income)
- Formal work (monetary income)
In these rural communities: Qom households, young households and movers had higher social vulnerability.
Host availability and the social vulnerability are associated to infected vector abundance.
How does the social vulnerability affect the ecological factors?

Dog-vector contact increases with social vulnerability and the effect is greater at lower vector abundance.
How the ecological and social factors interact to determine human infection?

- Host availability
- Social vulnerability index
- Age

Infected kissing bug
Infected humans
We combined entomological, epidemiological and serosurveys during 7 years.
Human infection prevalence

Age group (years) | % coverage | Number of people tested | Mid-period population (2012-2015)
--- | --- | --- | ---
70 and older | 44% | 40 | 70%
65 - 69 | 55% | 79 | 63%
60 - 64 | 52% | 56 | 62%
55 - 59 | 83% | 82 | 90%
50 - 54 | 76% | 78 | 84%
45 - 49 | 76% | 90 | 84%
40 - 44 | 66% | 74 | 87%
35 - 39 | 81% | 84 | 87%
30 - 34 | 83% | 100 | 100%
25 - 29 | 61% | 100% | 100%
20 - 24 | 69% | 80% | 99%
15 - 19 | 80% | 84% | 99%
10 - 14 | 87% | 90% | 99%
5 - 9 | 67% | 69% | 90%
How the ecological and social factors interact to determine human infection risk?

Infection risk model (GLMM)

- Age
- Ethnicity
- Gender
- Infected vector abundance
- Social vulnerability
- Host availability
- Infected co-inhabitants
- Infected mother
- Mobility

Comparison:
- Total population
- Children < 15 years old

- Arrows indicate the direction and magnitude of the interaction effects.
How the ecological and social factors interact to determine human infection risk?

Infection risk model (GLMM)

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Total population

- Children < 15 years old

Predicted probability

Age (years)

- Non-mover / non-infested domicile
- Non-mover / infested domicile
- Mover / non-infested domicile
- Mover / infested domicile
Risk maps to detect priority areas

All cases
Sensitivity: 83%
Specificity: 72%
FP: 19%
FN: 5%

Children <15 y.o.
Sensitivity: 87%
Specificity: 68%
FP: 29%
FN: 1%
1. Focal distribution of cases can be explained by social determinants of health: the social vulnerability index as a measure to identify high risk areas.

2. Dual role of domestic animals: they can divert vectors away from people but can increase vector abundance (poultry) and vector infection (dogs and cats).

3. The use of risk maps by control programs can help achieve sustainability of vector control, diagnosis and treatment of human infection, particularly in a context of constrained resources.
Vector surveillance and control needs to be guaranteed

Challenges and opportunities:

- Community participation in detecting new infestations is key but resources to address notifications from householders need to be available for locally-based control.

- Centralized (national or provincial) efforts are slow, late and inefficient in highly resilient systems.

- No current integration with other disease systems, but there is potential for integration:
  The social determinants of health can also determine the co-occurrence of other Neglected tropical diseases and health burdens.
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