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COMMUNITY RECOGNITION OF CHAGAS DISEASE TRANSMITTING VECTORS. AN EXPERIENCE IN SANTA ELENA, ECUADOR

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Absract: Chagas disease is a chronic systemic infectious disease caused by a flagellate protozoan *Trypanosoma cruzi*. This research had as main objectives: to identify the location of the triatomine in the sampling unit (house), to recognize the species of vectors in the commune and the knowledge of the disease, to relate the number of inhabitants per house with the number of people who have been bitten by the triatomine in the commune. A descriptive, non-experimental, cross-sectional field study was carried out in the Febres Cordero community, which is part of the Colonche parish, located in the province of Santa Elena, Ecuador. The sample was calculated with an error margin of 5% and a confidence level of 95%, corresponding to 241 households. For the recognition of Chagas disease vectors, the research team prepared brochures with images of the main five vectors and a technical sheet for the collection of information. The most identified triatomine bug by the inhabitants was the species *Rhodnius ecuadoriensis* in the interior of the dwellings (n=26; 76.47%) and also in the peridomicile (n=11: 55.0%). A higher frequency of bites (triatomine-human interaction) was found in dwellings inhabited by 5 people (n=5; 55.56%). Out of a total of 9 people who reported having been bitten by the vector, three of them reported sick family members. This study represents the first participatory work carried out together with the rural community that promotes the recognition of the transmitting vectors and deepens the knowledge of Chagas disease.
Keywords: identification, arthropods, spread, Trypanosomiasis, population.

INTRODUCTION

Chagas disease is an infectious, systemic and chronic disease caused by a flagellate protozoan *Trypanosoma cruzi* and transmitted accidentally from animal reservoirs to humans, generally by the bite of hemiptera (hematophagous arthropods) belonging to the Triatomine subfamily (1). The community commonly calls these vectors in different ways, such as, barbeiros, chipos, pitos, vichucas, among others and is recognized by the Ecuadorian population as chinchorros (2). Other non-vectorial transmission mechanisms are: 1) transfusion and organ transplantation, 2) congenital or vertical, from mother to child through the placenta, and 3) oral, through contaminated food or beverages (3).

Three phases of infection are described in Chagas disease. The acute phase, often subclinical, is characterized by fever, anorexia, headache, myalgia, arthralgia, and nausea, also lymphadenopathy, chagoma and the Romaña sign. These symptoms remit spontaneously (4). From this phase, the disease evolves in two possible ways: 1) it enters an indeterminate phase (70-80% of cases), when the patient will never develop symptoms related to Chagas disease; 2) the disease progresses to the chronic phase (20-30% of cases) with systemic involvement and development of visceromegaly, chagasic cardiomyopathy and other severe complications, which place it as the parasitic disease with the highest morbimortality (5).

Worldwide, there are between 8 to 12 million people infected with T. cruzi, including in Europe, North America, Japan and Australia. This geographical distribution is due to migration patterns from countries where Chagas disease is endemic (6). Thus, the migration of citizens from endemic countries has generated another way of knowing the real magnitude of the problem. In 2006, several immigrants from Latin America traveled to Canada, of whom an estimated 3.6% were infected; in 2007, others from Brazil, Peru, and other Latin American countries were infected. In 2008, Spain received 17390 Latin American immigrants, 5.2% of whom had the disease. In the United States, 2% of 17 million Latin

American immigrants in 2007 were in the same situation (7). Therefore, the prevalence of Chagas disease in Latin Americans living in Europe is 4.2% and in the United States it is estimated that more than 100,000 inhabitants are affected by the disease (6).

In this regard, in Latin America, Chagas disease is among the most prevalent tropical transmissible diseases. Currently, the World Health Organization (WHO) has proposed the elimination of Chagas disease as a public health problem in endemic and non-endemic countries by 2030 (8). According to reports from 2010, the three countries with the highest number of infected people were Argentina, Brazil and Mexico. New cases of vector-borne transmission were identified in Bolivia, followed by Mexico and Colombia. In the case of congenital transmission, cases were high in Mexico, Argentina, Colombia, Venezuela, Bolivia, Brazil, Ecuador and Paraguay (9).

In Ecuador, Chagas disease is endemic. There have been reported 17 species of triatomines; the most associated in the transmission of the disease are Triatoma dimidiata and *Rhodnius ecuadoriensis* (10). The latter has been incriminated as the main transmitting vector in the southern region of the territory. In the country, the National Chagas Program and the National Service for the Control and Surveillance of Arthropod Vector-borne Diseases (SNEM) was discontinued in 2015 and horizontalized to prevention and control strategies, carried out in the country since 2004 (11). Despite the poor responsiveness of control and prevention programs, in Ecuador, in 2021 (SE52) 170 cases were reported: 16 (9.4%) of Acute Chagas disease and 154 (91%) of Chronic Chagas disease (12).

Concerning previous related investigations, there are not many bibliographic references or related field work experiences in the country. However, organizations such as the Institute of Infectious and Tropical Diseases of Ohio University, together with national institutions, developed a sustainable model for the prevention of Chagas disease based on community participation and improvements in household infrastructure in rural communities in southern Ecuador (13) . *T. cruzi*, a highly adaptable parasite, requires further studies on the behavior of the vector. However, prevention and vector control strategies have not succeeded in controlling the disease in the country.

Another similar study, which consisted of identifying the presence of vectors at the household and peri-household level, in the localities of Arrastradero and El Limón in the city of Calceta, Cantón Bolívar, Province of Manabí, with the help of community leaders, visits were made and data were collected for the study. The study showed the presence of *Triatoma dimidiata*, in proportions lower than 5%, and of the hemiptera captured, none showed natural infection with *Trypanosoma cruzi* (14).

the active search for the vector of Chagas disease requires human and economic resources, a situation that cannot be replicated in developing countries in Latin America, Central America and the Caribbean, where this disease is endemic.

For vector control in Latin America and the Caribbean, community participation and the use of digital tools for triatomine recognition have been proposed (15, 16). Traditionally, community participation consists of improving housing structures and cleaning the peridomicile (17). In this study, community participation was proposed for the recognition and identification of the vector by using brochures and easy-to-use digital tools such as photographs from cell phone cameras and the capture of the vector in containers. This methodology allows the active study of the presence of *T. cruzi* in the samples obtained by the community and the search for new vectors of the disease, as well as the local behavior of the vector, months of appearance in the locality, flora and fauna associated with its presence, practices and skills involved with greater risk of transmission of the disease, among others.

The specific objectives of this research were: to identify the location of the triatomine in the sampling unit (house), to recognize the species of vectors in the commune and the knowledge of the disease and to relate the number of inhabitants per dwelling with the number of people who have been bitten by the triatomine in the commune.

MATERIALS AND METHODS

This was a descriptive, field, non-experimental, cross-sectional study. It was carried out from May 1 to 18, 2021. It occurred in the Febres Cordero commune, which is part of the Colonche parish, located in the province of Santa Elena, Ecuador. This commune is bordered in the northwest by the Loma Alta commune; in the south, by the Río Seco commune; and in the east, by the Salanguillo commune (18) (Figure 1). According to the 2010 population census, Colonche Parish has an estimated population of 31322 inhabitants (19). Based on information provided by the community leader (housing census), the Febres Cordero commune is inhabited by approximately 1,800 - 2,000 people, belonging to 850 families. The commune is divided into Upper and Lower Febres Cordero. There are multi-family dwellings (2-3 families) living in the same house. In order to know the real number of houses in the community, the researchers made previous visits to the area and made a sketch (Figure 2) which allowed them to know with certainty the real number of houses. Next, the sample size was calculated, with a margin of error of 5% and a confidence level of 95%, which corresponded to the 241 families that were surveyed. Prior to the application of the survey and the approach to the households, it was conducted a two-week training period for volunteers who wished to participate in the study (face-to-face and virtual), due to the SARS-CoV-2 pandemic. The training consisted of the recognition of the vector species of Chagas disease, through the use of image primers, digital tools and active search of the vector by the community itself, with the support and guidance of the project researchers, including an entomologist, as well as the differentiation of other similar insects that could have clinical relevance.

Figure 1. Map of Colonche Parish. Source: Development and Land Management Plan. Year 2015

Figure 2. Map of Febres Cordero: Upper and Lower

For the recognition of the vectors of Chagas disease, the research team prepared brochures with allusive images of five vector species (*Triatoma dimidiata*, *T. infestans*, *Rhodnius ecuadoriensis*, *R. prolixus* and *Pastrongilus geniculatus*) (Figure 3). For the collection of information, a structured instrument was designed in sections that allowed to obtain the variables established on the study objectives (Technical Sheet). The technical sheets were completed by two residents of the community, at the request of the community leader after having received an induction, through the Zoom platform, regarding the correct filling out of the data sheets. The technical sheets were divided in blocks from A to F. These were A) Affiliation data, B) Epidemiological history: environmental variables, socioeconomic information and housing data, C) Background related to the disease: obstetric history and associated comorbidities, D) Entomological data, E) Knowledge, practices and attitudes, F) Intervention. In this study the team was focused on section B about the housing data, which included physical characteristics of the dwelling and number of inhabitants per housing unit and section D, entomological data, which included the place where they had seen the chinchorros, and identifying the species. Also, along with filling out the form, each household was provided with a protection kit and followed by the gathering of information. Subsequently, a visit was made to the area to verify the correct filling out of the forms (Figure 4) and to corroborate with the residents along with the researchers and volunteers of the project (Figure 5), all of whom worked together to obtain data, and to collect specimens located in the homes and peri-homes of the community. The characteristics of the species observed were verified and explained to the inhabitants by the research team as corresponding to those described in the literature in relation to the vectors of Chagas disease.

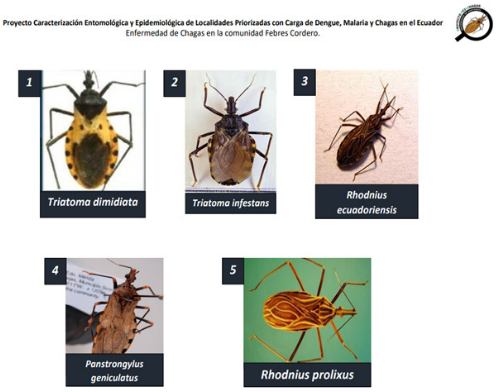

Figure 3. Triatomine identification cards

Figure 4. Field work in the community. Approach to the dwellings

Specimens were collected manually using plastic containers and tweezers, then transported to the laboratory. The specimens were captured with the help of the research team, by technicians and/or entomologists. The triatomines collected were placed in containers identified with codes (house, population center and municipality), covered with tulle cloth and fastened with rubber bands. The samples of the collected specimens were identified taking into consideration the morphological characters of each species collected. For the diagnosis of the species, the taxonomic determination was carried out according to the keys of Lent and Wygodzinsky (1979) (20). This activity was carried out at the Laboratory of Tropical Pathologies (Center of Excellence. Faculty of Medical Sciences. University of Guayaquil). The specimens that arrived alive at the laboratory were examined individually to determine if they were infected by *T. cruzi*. For this purpose, drops of fecal material obtained by abdominal pressure were diluted on a slide with a few drops of saline solution and examined under a microscope at 400X.

Figure 5. Volunteers from the community and the research team

RESULTS

A total of 241 houses were inspected. The houses were mostly built of cement or wood, with zinc roofs and ceramic, wood, cement or dirt floors, also surrounded by emergent vegetation. Palm trees of the Araceae family were always present in front, around or behind the house (Figure 6).

The community claimed to have seen five of the vectors of Chagas disease. The most commonly identified triatomine by the inhabitants were *Rhodnius ecuadoriensis* inside the housing units (n=26; 76.47%) and in the peridomicile (n=11: 55.0%) followed by *Triatoma infestans* (n= 3; 8.82%) at home (Table 1).

Figure 6. Typical house of the Febres Cordero community. Colonche Parish. Santa Elena-Ecuador.

Table 2 shows the maximum number of inhabitants per dwelling in the community and the response to the question whether they have been bitten by the triatomine bug or not. The highest frequency of bites (triatomine-human interaction) was found in homes with 5 inhabitants (n=5; 55.56%), followed by homes with 6 inhabitants (n=3; 33.33%) and finally, homes with 4 inhabitants (n=1; 11.11%). A considerable number of inhabitants per dwelling had not been stung (n=58; 25.0%). Out of a total of 9 people who reported having been bitten by the vector, three of them reported having family members with the disease.

N° of inhabitants per dewelling	Bitten by the triatomine bug				Total
	Yes	%	No	%	
1	0	0%	12	5.17%	12
2	0	0%	27	11.64%	27
3	0	0%	47	20.26%	47
4	1	11.11%	58	25.00%	59
5	5	55.56%	39	16.81%	44
6	3	33.33%	27	11.64%	30
7	0	0%	13	5.60%	13
8	0	0%	2	0.86%	2
9	0	0%	5	2.16%	5
10	0	0%	2	0.86%	2
Total	9	100%	232	100%	241

Table 2. Number of inhabitants per dwelling versus bitten by the triatomine bug. Febres Cordero community. Santa Elena. Ecuador Year 2021

Source: Study data

DISCUSSION

The conditions of the dwellings in the commune, coincide with favorable factors for the habitat of the triatomine. Studies carried out about the characteristics of indigenous habitats and the risks of infestation of the different vector species of Chagas disease in

	Hábitat							
Specimens	**Domicile**		**Peridomicile**		**Both**		**Extradomicile**	
	Fa (n)	Fr (%)	Fa (n)	Fr (%)	Fa (n)	Fr (%)	Fa (n)	Fr (%)
Triatoma dimidiata	0	0%	4	20 %	1	25%	0	0 %
Triatoma infestans	3	8.82 %	2	10%	1	25%	0	0 %
Rhodnius ecuadoriensis	26	76.47 %	11	55%	1	25%	2	66.67%
Rhodnius prolixus	2	5.88 %	2	10%	1	25%	0	0%
Pastrongilus geniculatus	2	5.88 %	1	5%	0	0%	1	33.33%
Others	1	2.94 %	0	0%	0	0%	0	0 %

Table 1. Chagas disease vector species recognized by the Febres Cordero community and their location regarding domicile. Santa Elena. Ecuador. Year 2021

Source: Study data

Colombia, indicated that there is a relationship between the species that colonize the dwelling with the materials in which they are built. Dip et al (21) point out that, while the Rhodnius genus preferentially colonizes huts with palm roofs and cane or wood walls, insects of the Triatoma and Panstrongylus genus seem to prefer dwellings with thatched roofs and stone or mud walls. However, the presence of adult vectors of different species that have not colonized the living spaces, regardless of its characteristics and location, make the risk factor of transmission with wild species to be present in a generalized way (21). Another important aspect as a result of the home visit in this study was the presence of palm trees of the Araceae family, one of the favorite places of kissing bugs. Although they were not present in all the housing units, it was recommended to remove dry leaves, which are the main nest of the vector.

Avila Montes et al. (22) selected two communities in Honduras: one experience of control and another experience of intervention. It was found that the respondents knew some of the triatomine breeding sites and that they also fed on blood. Another experience reported by Dip (2011) allowed to gather information about the disease in indigenous communities of the Sierra Nevada de Santa Marta in Colombia. Technical documents edited by PAHO, reveal that the vector species are even part of the culture, by embroidering representations of vectors in wool fabrics of the indigenous backpack of the Arhuaca ethnic group.

The vectors found indoors were mainly on walls, living room, ceiling, bedroom, kitchen and wooden furniture. In the peridomicile, vectors prevailed in the vegetation, wood residues and pens. In the present study, triatomines prevailed indoors. However, other study (23) mentions that wild triatomines began to be located outdoors because of the use of palm trees as a source of refuge, and wild animals near homes as a source of food, having better peridomicile conditions than intradomicile. In another study, carried out in the Municipality of Coloso, Colombia, 90% of the triatomines in the study were captured outside the home, 7.5% indoors and 2.5% indoors by community surveillance (24).

The training of the volunteers played an important role in facilitating the correct identification of the vectors by taking photographs and sending them to the researchers of the project. Similarly, the visit to the house units of the commune by the researchers inspired confidence in the inhabitants and facilitated the work. It should be noted that other aspects that facilitated and encouraged teamwork, were the previous visits to the community to establish meetings with decision makers, and the definition of a neutral meeting space (church) before carrying out the house-to-house approach.

On the other hand, the use of the primers allowed the residents of the community to identify and differentiate the five species that prevailled in the country. In fact, arthropods, similar to triatomines, were collected. Therefore, the environmental characteristics of the area, favor the presence of a variety of arthropods with an appearance and behavior very similar to the triatomine, which have not been described to date as transmitters of *Trypanozoma cruzi*, but which may have clinical relevance.

People from the Febres Cordero commune reported seeing five of the 17 species of triatomines reported in Ecuador. The most commonly identified vector by the inhabitants were: *Rhodnius ecuadoriensis* (65.57%) and *Triatoma infestans* (9.84%). *R. ecuadoriensis* and *T. infestans* were recognized inside the house, on walls, on furniture in the bedroom, living room, and in the kitchen of the dwellings. *R. ecuadoriensis*, was also observed in the peridomicile. 81.8% of these houses had animals, mainly poultry. In this study, the only species that was infected with *Trypanosoma spp*. was *R. ecuadoriensis*, in a specimen captured at the address of a house located in the center of the commune.

Out of the five vectors identified by the community, *R. ecuadoriensis* has been described as the main vector of Chagas disease in the province of Manabí, being both present at home and peridomicile, as well as in the southern part of the country (10). However, a study carried out in the Canton General Villamil Playas shows a prevalence of the *T. cruzi* parasite in the *T. dimidiata* vector in 22% of the urban area of this community (25). Likewise, in a research carried out in the Juan Gómez Rendón parish, belonging to the Guayaquil Canton, in the Province of Guayas, it was identified *T. dimidata*, finding that 28% of these were infected with *T. cruzi* (26). On the other hand, in the Ecuadorian Amazon, the vectors *Rhodnius pictipes*, *Rhodnius robustus*, *Panstrongylus geniculatus*, and *Triatoma carrion* are found (27).

Likewise, a research aimed at comparing the phenotypes of the species *R. ecuadoriensis* in Loja and Manabí, showed that the vector *R. ecuadoriensis* is present in both regions, with phenotypic differences. The authors found that the size of the arthropods in Manabí varies according to the size of the body and their dimensions were larger than those of Loja. In Manabí, the wild and domestic species had the same characteristics, in contrast to those found in Loja, the size of the wings varied. (28)

Regarding the number of people bitten by the triatomine and its relationship with the number of inhabitants per dwelling, Paredes González et al. (29) reffers that, although it was not possible to collect triatomines in the beds, the residents reported to have suffered frequent bites while they slept, even after having looked for the insect and trapping it between the mattress and the bed bars, a particularity that, according to the residents, is repeated every hot season. In this regard, in a research aimed at evaluating the processes of invasion of wild triatomes to a home environment, it is related to the lack of availability of domestic animals for food or shelter and change in the external environment. This is not related to the number of inhabitants inside a housing unit, but rather to external changes in the environment (30). This data, sometimes difficult to specify in the interviewee, in our case, was remembered by the residents and even collected and stored, a situation that is also related to the hottest season in the area. Another important aspect is the fact that during the research process of the species using the primers, they were easily identified by a color or some outstanding morphological character that caught their attention.

The number of people affected with Chagas in endemic places depends on other factors, such as the construction material of the houses, the species of triatomine, and its collection place: in a wild or domestic area (8). The study showed that the houses with the largest number of inhabitants were not bitten by the triatome. On the other hand, in the dwellings in which between 4 and 6 inhabitants live, the interviewees indicated that they were bitten at least once.

Considering all the points mentioned above, it is important to alert health personnel at the first level of care, in the Febres Cordero commune, about the existence and differentiation of Chagas disease vectors, with other arthropods with similar characteristics. This will serve to improve the understanding, orientation of the diagnosis and treatment of Chagas Disease in the community.

CONCLUSIONS

It is necessary to continue generating experiences of community participation in areas where Chagas disease is endemic and to continue exploring new areas where the triatomine could colonize. Also, to reinforce basic knowledge about Chagas disease, before establishing prevention and surveillance measures that involve the active participation of its inhabitants. In this sense, it is important to analyze in depth the reasons why the community does not participate permanently and that this tool becomes a contribution to promote collaboration through learning in health to face the disease.

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Consent for publication: the authors of this research authorize its publication, once approved by a double blind peer review.

Authors' contributions: The authors confirm contribution to the paper as follows: study conception and design: GCVS – CJGY; data collection: CJGY – GARV – KJCM; analysis and interpretation of results: GCVS – CJGY; draft manuscript preparation: GCVS – CJGY. All authors reviewed the results and approved the final version of the manuscript.

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