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Perceptions of Problems with Household Insects: Qualitative and Quantitative Findings from Peri-Urban Communities in Arequipa, Peru

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Abstract. Vector-borne diseases continue to impose a major health burden on Peru and neighboring countries. The challenge of addressing vector-borne disease is compounded by changing social, economic, and climatic conditions. Peri-urban Arequipa is an important region to study insect infestations because of ongoing challenges with disease vectors such as triatomines and a variety of other insects. We conducted surveys ($N = 1{,}182$) and seven focus groups (average seven participants) in peri-urban Arequipa to explore knowledge of and perception toward various insects that infest the region. Focus group participants reported the presence of a wide variety of insects in and around the home, including disease vectors such as triatomines (also identified by 27.2% of survey households), mosquitoes, spiders, and bed bugs, as well as nuisance insects. Health concerns related to insects included vector-borne diseases, spider bites, allergies, and sequelae from bed bug bites, and hygiene concerns. A majority of participants in the quantitative surveys identified triatomines as the insect they were most worried about (69.9%) and could identify Chagas disease as a health risk associated with triatomines (54.9%). Insect infestations in peri-urban Arequipa present multiple burdens to residents, including injury and illness from triatomines and other insects, as well as potential mental and economic concerns related to insects such as bed bugs. Future initiatives should continue to address triatomine infestations through educational outreach and implement a more holistic approach to address the burden of both disease and nuisance insects.

INTRODUCTION

Vector-borne diseases represent a major health burden in Peru and Latin America.[1] In 2016, the combined incidence of malaria, dengue, yellow fever, Zika, Chagas disease, and leishmaniasis in Andean Latin America (including Bolivia, Ecuador and Peru) was estimated at more than 885,000 cases with approximately 590 fatal cases transmitted by mosquitoes, triatomine insects, and sandflies.[1]

In Arequipa, Peru, the health burden associated with insects intensified with an increase in the triatomine vector population and Chagas disease transmission during the 1980s and 1990s.[2–4] In 2003, the Peruvian Ministry of Health initiated a large-scale intermittent residual spray (IRS) campaign, which is considered the most cost-effective way to prevent new Chagas' disease infections.[5] IRS spray campaigns offered insecticide spraying for households within Arequipa over the course of three phases: a preliminary survey phase (in which houses are surveyed for the presence of triatomines), an attack phase (in which health promoters explain the process of insecticide application and apply insecticide to houses and adjacent farms), and a surveillance phase (in which houses are monitored for repeat infestation).[6] Despite nearly 2 decades of organized vector control efforts, infestations with Chagas-carrying triatomine insects is an ongoing issue in Arequipa.[7–9]

Health threats from other insects are also pervasive. The incidence of mosquito-borne disease remains high in Peru[10,11] and is affected by changes in climate and extreme weather events.[12] Evidence of *Aedes aegypti*, the primary vector of dengue, chikungunya, Zika, and yellow fever in Latin America, was reported in the northern coastal areas of Arequipa of Peru for the first time in 2016[13] and may represent an emerging threat of mosquito-borne disease in lower-lying areas of the state. Spider bites, specifically from the species *Loxosceles laeta*, a relative of the brown recluse spider, constitute the majority of venomous animal bites in Peru and are occasionally fatal.[14] Human epidermal parasitic infections such as scabies (mites), pediculosis (lice), and tungiasis (fleas) can also cause pain and discomfort, exposure to pathogenic bacteria, and psychological and social impacts.[15,16]

Household insect prevention practices and participation in insecticide campaigns are affected by household member perceptions of the problems associated with household insects[5,17,18]; moreover, sometimes people are more aware of or bothered by nuisance insects than those that are harmful. To address vector-borne disease with a community-oriented framework, it is important to generate a holistic characterization of the types of insects that household members perceive in households in this region, and their association with illness, injury, and other negative impacts, including social stigma. The objective of this study was to describe the experiences and perception of household members in peri-urban communities of Arequipa, Peru, regarding household insects and the impact these have on household health and safety.

MATERIALS AND METHODS

Ethics statement. Institutional review board approval was obtained from Universidad Peruana Cayetano Heredia (approval identification number: 65369), Tulane University (approval identification number: 14-606720), and University of Pennsylvania (approval identification number: 823736).

Study setting. This study was conducted in peri-urban Arequipa, a major city (population 1,008,290) in the Andean region of Peru. Data for this study were collected from the

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districts of Alto Selva Alegre (ASA, population 83,314; density: 11,936.1 people/km^2) and Cerro Colorado (CC, population 149,786; density: 856.41 people/km^2), both located in the periphery of the city.[19,20] Both ASA and CC are heterogeneous districts that consist of a mix of traditional neighborhoods developed in the 1800s and *pueblos jovenes*, or new neighborhoods. *Pueblos jovenes* are peri-urban neighborhoods that were settled in the 1980s and 1990s largely by migrant workers from rural Peru in search of work in the city.[3] Residents often bring aspects of rural life with them to the city, including tending poultry or guinea pigs in small, home-based farms.[3] Although some of these communities may become increasingly connected with the city center over time, their inhabitants tend to have less access to city infrastructure and face greater barriers to obtaining medical and social services offered in traditional neighborhoods.[3,20,21] These migration patterns, living arrangements, and lack of healthcare access in peri-urban areas led to relatively high incidence of (4.8%) of Chagas disease infection in children in other peri-urban districts before public health interventions.[2,7,22] Thus, peri-urban areas were chosen as the location of early IRS campaigns by the Peruvian Ministry of Health and as the focus of our randomized control trial of behavioral health interventions.

Recruitment and sampling. Door-to-door recruitment was performed by a member of the research team in the peri-urban district of ASA as part of a larger randomized control trial that assessed the efficacy of various behavioral interventions to increase participation in an IRS campaign. A total of 1,200 individuals in ASA were invited to complete the survey irrespective of participation in the spray campaign: 300 households randomly selected from each of three study arms and the one control area that were part of the larger study.[23,24] A baseline survey conducted 1 to 2 weeks before indoor spray campaigns was performed with household members who consented to participate (N = 1,182). Written consent was obtained from willing participants, and the survey was conducted by a research assistant.

Additional participants were recruited for separate focus groups (FGs) to examine similar themes to the surveys in greater detail. Focus groups took place in the districts of ASA and CC (n = 49 participants). Purposive sampling was used to recruit FG participants: purposefully recruiting individuals with residence in ASA or CC districts and who had experienced a self-reported domestic insect infestation of triatomines or bed bugs within the previous 2 years or who lived within four blocks of someone with infestation of these insects. Each FG contained at least one participant who had experienced each type of infestation (triatomine or bed bug); no FG had exclusively participants with triatomine or bed bug infestations. In addition to triatomines, bed bugs were of particular interest because they have been shown to also carry *Trypanosoma cruzi*, the parasite that causes Chagas disease, in a laboratory setting.[25]

We aimed for 8 to 12 participants for the FG discussions, so more than 12 eligible participants were invited to each group to achieve a minimum of six participants. Participants were given transportation from their homes to the FG location and provided compensation for their transportation home. Verbal consent for FG participation and to authorize audiotaping was obtained from all participants before starting the discussions.

Management and analysis of survey data. The surveys were conducted on tablets using CommCare software[26] and uploaded to CommCare software daily from Arequipa. Every day, the number of forms filled by each interviewer in the system was compared with the forms reported by the interviewers. The database was also reviewed daily to detect possible inconsistencies in the information collected (missing data and filling errors). Errors detected were reported and resolved if possible. Data were extracted and analyzed in STATA 14.1 (StataCorp, College Station, TX).

Focus group methods.

Sampling strategy and recruitment. Purposive sampling was used to recruit participants for the FG discussions: purposefully recruiting individuals with residence in ASA or CC districts and who had experienced a self-reported domestic insect infestation of triatomines or bed bugs within 2 years, or who lived within four blocks of someone with infestation of these insects. Those who lived within four blocks of someone with an infestation were not informed of their neighbors' infestation status but rather were recruited door-to-door by staff who were aware of the geospatial location of infestations. Each FG contained at least one participant who had experienced each type of infestation (triatomine or bed bug); no FG had exclusively participants with triatomine or bed bug infestations.

We aimed for eight to 12 participants for the FG discussions, and recruitment strategies were followed until capacity was reached. More than 12 eligible participants were invited to each group to achieve a minimum of six participants to account for anyone who had to opt out. Participants were given transportation from their homes to the FG location and provided compensation for their transportation home. Verbal consent for FG participation and to authorize audiotaping was obtained from all participants before starting the discussions.

Management and analysis of FG data. The facilitation team used an FG guide to ensure similar overall concepts were explored in all groups. The FG guides consisted of questions designed to elicit discussion of four deductive themes that were determined before the FGs: problems with insects in the home, fear of insects, health impacts of insects, and management of infestations. FG recordings were transcribed in Spanish and analyzed using a multistep mixed deductive and inductive coding process. Transcripts were reviewed using a code book that contained the four main deductive themes described earlier: problems with insects in the home, fear of insects, health impacts of insects, and management of infestations. Subcodes within each of these four main groups were developed based on the FG text using an inductive process.[27] The transcripts were then coded in ATLAS.ti 6.0. The summarized material from three of these themes is presented in the following section, along with relevant quotes illustrating key points. Because of the volume of material collected and analyzed in these FGs, the fourth theme (management of infestations) has been published in a separate article.[18]

RESULTS

Study population. The total number of participants in the survey component of this study was 1,182, with 64% (758) women and 36% (424) men. All surveys were conducted within the ASA district, Arequipa. Regarding the FG, 49 individuals participated in seven FGs (four in ASA, three in CC)

TABLE 1
Focus group characteristics

Focus group	Location	No. of participants	Mean age
1	ASA	9	47 (19–74)
2	ASA	3	48 (36–55)
3	CC	6	50 (26–78)
4	CC	8	66 (42–80)
5	CC	8	47 (20–78)
6	ASA	8	45 (21–68)
7	ASA	7	47 (30–76)

ASA = Alto Selva Alegre; CC = Cerro Colorado.

with an average size of seven participants. The FG participants' age range was 18 to 81, with 73% women ($n = 36$) and 27% men ($n = 13$) (Table 1).

Presence of insects in the home and surrounding environment.

Types of insects. Focus group participants reported seeing a range of insects in their homes or neighborhoods: triatomines (*chirimachas*), mosquitoes (likely *Culex* quinquefasciatus, referred to as both *zancudos* and *mosquitoes*), ticks, spiders (including the *violinista*, a species of brown recluse), ants, flies, bed bugs, moths, mites (*ácaros*), lice that affects guinea pigs (*itas*), cockroaches, beetles (often referred to using the same word as "cockroaches" in Arequipa), and a small white insect on plants (likely aphids or white flies). (Note: we have attempted to use the true name of the insect in the text rather than a direct translation of how the insect is referred to; to avoid confusion, we also made a terminology table to explain the ambiguities; see Table 2). In the survey that focused on specific insects and the period before the spray campaign, we found that of the 1,182 participants, 27.2% had seen triatomines in their homes at some point in their lives, and 36.5% had not seen them in their home but had seen them elsewhere. Regarding bed bugs, 2.4% had seen bed bugs in their homes at some point in their lives, and 12.8% had seen them elsewhere (Table 3).

Home environment. One ASA participant summarized a common belief: "I think insects come from dirtiness; you have to keep your house clean." Insects in general, and particularly flies, ants, and cockroaches were associated with "dirty" homes, food residue, and garbage. Participants emphasized cleaning dark areas of the house and moving furniture to get rid of spiders: "everything depends on cleanliness … we have to clean the house from corner to corner and move the furniture from one side to another" (Participant, CC).

Participants noted housing characteristics that attract insects: certain building materials, temperature, and humidity. Triatomines were associated with walls made of cinder block (*bloquetas*) that have many crevices and tend to be warm. Flies were drawn by heat and warmth. One participant reported that mosquitoes came into the house to drink water, whereas others described them coming into the kitchen or into areas of the home with plants. There was also awareness of the types of insects that might be associated with certain house animals, including, for example, that *chirimachas* were associated with specific animals such as guinea pigs (*cuy*) and small rabbits (*conejitos*, a term used locally to refer to rabbits and guinea pigs), as well as wooden pens, chickens and chicken coops, pigs, and dogs.

> *The* chirimacha *has invaded us. At least it has come to me [my house], it seems that there are neighbors who raise guinea pigs, hens. … I have preferred to spray, twice, both times in my house, I have had it fumigated. … I went to the health facility, and they did not want to attend me. [I told them] "Look, I have* chirimachas*. I do not have animals." … I have a puppy, but I don't have hens or guinea pigs. … [It has started in one house and] from there to the neighbors [the* chirimachas *have moved] to every neighbor.*
>
> *—Participant, ASA*

Neighborhood and external environment. The neighborhood environment, particularly neighbors' animals, was considered an important determinant of household insects.

> *I have the nets so that flies do not enter the kitchen, for example, we put those nets and they don't enter, but they always come because the neighbor has a farm. … From there all the flies come in the afternoon, they are on the black door and what do I do? I buy spray, I use it, I spray it in the night, and they all die. At dawn they are dead …, but the next day they come just the same.*
>
> *—Participant, CC*

TABLE 2
Explanations of terms and ambiguities used by participants

Spanish	Translation and ambiguities
Zancudos	*Zancudos* is often used among the study population to refer to mosquitoes, from the Culicidae family. However, *Zancudo* could also refer any type of flying insect that bites and feeds on blood.
Mosquitos	*Mosquitos* is usually used to refer to flying insects that are small and do not make perceptible sounds when they fly, including some from the Simuliidae family, commonly known as midges. However, it can also refer to mosquitoes.
Itas/hitas	A type or types of lice that affects guinea pigs and other livestock.
Cucarachas	The German cockroach, *Blatella germanica*, is present in Arequipa and nearby regions, and the term *cucaracha* may refer to it. However, the word is also used, not infrequently, to refer to some beetles of the Tenebrionidae family, especially in poorer peri-urban communities of the city.
Mosquitas	The form *Mosquitas* is occasionally used for fruit flies of the family drosophilidae and also for flies of the genus Simulium.
Conejitos	The literal translation from traditional Spanish would be little rabbits; however, *Conejitas* is commonly used to refer to guinea pigs in the study population. *Liebre* is more commonly, and more specifically, used for rabbits.
Garrapatas	In Arequipa, ticks of the family *ixodidae* and *argacidae* can be found. Some specimens of the genus *Argas* have also been reported in the city.
Bloqueta	Rectangle-shaped hollow structures used for construction that can be made only of concrete or with a combination of coal cinders and concrete.
Sillar	A volcanic chert, usually white, that is cut into rectangular blocks for construction.

TABLE 3
Presence of insects among a sample of participants in Alto Selva Alegre, Arequipa

Question	Insect types All survey participants, N = 1,182			
Have you ever seen one?	Triatomines, *n* (%)	Bed bugs, *n* (%)	Flies, *n* (%)	Ants, *n* (%)
No	382 (32.2)	787 (66.6)	4 (0.3)	37 (3.1)
Yes—in this house	322 (27.2)	28 (2.4)	1,125 (95.2)	935 (79.1)
Yes—somewhere else	431 (36.5)	151 (12.8)	51 (4.3)	209 (17.7)
Did not know/did not respond	47 (4.0)	216 (1.3)	2 (0.2)	1 (0.1)
Total	1,182 (100)	1,182 (100)	1,182 (100)	1,182 (100)

It is my understanding that [my neighbor] has Chagas disease. That is why when it [a triatomine] appeared in the house, it was because the neighbor had animals—plenty of chickens—and also nearby there was a land lot where everyone threw trash.

—Participant, ASA

When asked what insects were prevalent in their own communities, participants in ASA named ticks, due to an abundance of street dogs, and fleas, also associated with dogs. Participants reported being bitten by mosquitoes from the street or patio as well as in the home, and one explained that mosquitoes could not be avoided because they were present outdoors.

And for … those mosquitoes, how do you try to eliminate them?

Participant 1: There's no way because they're in the patio, the mosquito is in the environment [everywhere around you].

You can't…

Participant 2: You go out with shorts and your T-shirt, and they're stinging you, I mean, They're everywhere!

—CC

Exposure to insects was also linked to factors in the external environment such as travel and work outside the home, as well as nearby farms or animals.

… if you take a trip to a place, you must bring those insects, ticks, bed bugs—you can bring them to your house.

And what sites could those be?

For example, where I am working, there are plenty of all these things, now that I think about it, I am bringing them to my house in my suitcases, in my clothes, in my shoes and my things, right?

—Participant, CC

Temporal and seasonal variation. Participants described temporal and seasonal variation to the different insects affecting them. Mosquitoes were noted to appear in hot and rainy seasons with humidity, and one participant noted that insect infestations have increased due to variation in climate. Another participant reported an elevation in the mosquito population in the previous year due to the El Niño phenomenon, which was accompanied by unusual heat. Triatomines, bed bugs, and mosquitoes were described as emerging at night. Participants also were aware of new insects they had not seen in their region before and reported observing a new type of *mosquitas* (which our team identified as the fly species *Simulium escomeli*), referred to by participants as smaller than flies, daytime biting, and, in ASA, it was described as being "yellow."

Participant 1: Every year [the population of flies] keeps increasing.

And why do you think? Why could this be?

Participant 2: The infestation.

Participant 3: I don't know, it could be seasonal.

Participant 1: The climate has changed, I mean, the seasons of rain and heat have varied, then, it seems that the infestations are also changing, I feel also that they have increased.

Yes, and since when have you been noticing this fly?

Participant 1: Since 5, 6 years ago.

—CC

Participant 1: There are also yellow flies that take your blood and bite badly.

Those are *zancudos*?

Participant 1: No, [these are] little yellow flies [*Simullium escomeli*].

Participant 2: But they weren't there before. They just recently appeared now.

—ASA

Health risks associated with insects.

Health risk versus nuisance insects. Of the 1,182 survey respondents, 69.9% considered triatomines to be the most concerning insect overall, followed by spiders (16.3%) and flies (10.3%). Triatomines were also the insect respondents most wanted to get rid of (80%), followed by flies (15.7%). However, flies were considered the most bothersome insect (71.1%), followed by triatomines (12.2%) and spiders (11.8) (Table 4).

Survey participants were asked what diseases could be transmitted by triatomines, bed bugs, flies, and ants as an open-ended question. Slightly more than half (54.9%) reported that triatomines could transmit Chagas disease, whereas 41% did not know what disease triatomines transmit; a minority (0.3% or four individuals) said that triatomines could not transmit disease. An additional 3.8% stated that

TABLE 4
Perceptions of Insects among a sample of participants in Alto Selva Alegre, Arequipa

Insects Type	Perceptions of insects all survey participants, $N = 1,182$		
	Most worried about, *n* (%)	Most bothersome, *n* (%)	Most want to get rid of, *n* (%)
Triatomines	**826 (69.9)**	144 (12.2)	**946 (80.0)**
Flies	122 (10.3)	**840 (71.1)**	185 (15.7)
Bedbugs	21 (1.8)	10 (0.9)	25 (2.1)
Ants	20 (1.7)	49 (4.1)	26 (2.2)
Spiders	193 (16.3)	139 (11.8)	–
Total	1,182 (100)	1,182 (100)	1,182 (100)

Bold values indicate the insect's primary concert for each category.

triatomines transmitted other diseases, some of which were possibly related to Chagas disease (e.g., "illnesses in the blood" and "death if they bite us"), whereas others were unrelated (e.g., "cancer," "flu," "malaria") (Table 5). More than half of participants believed that flies could transmit diarrheal illnesses, and an additional 8% specifically named typhoid (Table 5). Most participants (95.3%) reported that they did not know of illnesses that could be transmitted by bed bugs.

Fear of insects. When probed about which insects were considered most dangerous, FG participants reported triatomines and venomous spiders. In two FGs in ASA, participants reported that they or a family member had been bitten by spiders and triatomines. Venomous spiders, particularly the *violinista* (the Chilean recluse spider, *Loxosceles lata*), were reported to be a highly dangerous insect because of the risk of tissue damage, or occasionally death, without rapid medical attention. Bites from triatomines were also viewed as dangerous because of the possible subsequent Chagas disease, with participants describing the risk of medical complications and death and the need to seek quick medical attention. Spider bites were considered more immediately lethal than triatomine bites, which were considered dangerous because they would not necessarily be noticed, and Chagas disease could therefore go unnoticed. One participant reported two incidents in which a member of her family sought medical care for spider and triatomine bites.

Which is the most dangerous?

Participant 1: How do you call it? The chirimacha *[triatomine].*

Participant 2: Chirimacha.

Participant 1: It sucks blood, that bring Chagas disease, and it lasts a long time in the body and it's harmful.

What happens to you with Chagas disease?

Participant 1: The organs start deteriorating with the passage of time, and you can die with this.

—CC

Participants or family members in both sites also reported being bitten by bed bugs, with reported outcomes ranging from unbearable itching or allergic responses, to fever, to persistent allergies years later.

Flies and cockroaches were also associated with illness, but these focused on hygiene concerns. No participants reported specific illnesses in themselves or family members, but multiple participants described flies or cockroaches as the "most dangerous" insect due to fears of contamination.

You said the cockroach [was the most dangerous]?

Participant: Because we don't know where they are. We have the food, sometimes it's covered, no? … We are eating something and we don't know, right? Then what we are eating has cockroach waste.

—ASA

Tick-borne disease was mentioned briefly: one participant in CC was bitten by ticks in Cuzco, although it was unclear whether he had been ill, and participants in CC noted that they had heard that ticks would enter in the ear, place eggs, and the person who was bitten would feel tired.

Stigma associated with insects. We examined the possible stigma associated with having certain insects in one's home or concern about children being exposed to these insects among participants who were familiar with triatomines ($n = 1,024$), bed bugs ($n = 221$), flies ($n = 1,182$), and ants ($N = 1,182$).

Participants expressed the greatest concern about allowing children to play in homes with triatomines. The majority of participants (86.6%, $n = 1,024$) reported that they would not allow their kids to play in their best friend's house if there

TABLE 5
Perceptions of health risks of insects among a sample of participants in Alto Selva Alegre, Arequipa

Diseases transmitted Type	Insect types All survey participants, $N = 1,182$			
	Triatomines, *n* (%)	Bed bugs, *n* (%)	Flies, *n* (%)	Ants, *n* (%)
None	4 (0.3)	6 (0.5)	5 (0.4)	163 (13.8)
Chagas	649 (54.9)	30 (2.5)	–	–
Diarrheas caused by viruses, bacteria	–	–	673 (56.9)	–
Typhoid	–	–	95 (8.0)	–
Other illness	45 (3.8)	20 (1.7)	62 (5.3)	89 (7.53)
Total	698 (59.0)	56 (4.7)	835 (70.6)	252 (21.3)

TABLE 6
Perceptions of Insects among a sample of participants in Alto Selva Alegre, Arequipa

	Stigma of insects (among participants familiar with the insect)			
	Triatomines, *n* (%) *N* = 1,024	Bed bugs, *n* (%) *N* = 221	Flies, *n* (%) *N* = 1,182	Ants, *n* (%) *N* = 1,182
Tell best friend if saw it in their house				
No	29 (2.8)	37 (16.7)	295 (25.0)	300 (25.4)
Yes	986 (94.5)	140 (63.3)	798 (67.5)	763 (64.6)
Don't know	28 (2.7)	44 (19.9)	89 (7.5)	119 (10.0)
Let your kids play in best friend house if saw in their house				
No	903 (86.6)	155 (70.1)	569 (48.1)	512 (43.3)
Yes	71 (6.8)	26 (11.8)	469 (39.7)	507 (42.9)
Don't know	69 (6.6)	40 (18.1)	144 (12.2)	163 (13.8)
Tell neighbor if saw it in their house				
No	257 (24.6)	84 (38.1)	551 (46.6)	578 (48.9)
Yes	633 (60.7)	82 (37.1)	444 (37.6)	398 (33.7)
Don't know	153 (14.7)	55 (24.9)	187 (15.8)	206 (17.4)
Let your kids play in neighbor house if saw in their house				
No	884 (84.8)	164 (74.2)	731 (61.8)	685 (58.0)
Yes	36 (3.4)	9 (4.1)	258 (21.8)	279 (23.6)
Don't know	123 (11.8)	48 (21.7)	193 (16.3)	218 (18.4)

were triatomines, relative to 70.1% ($n = 221$) of respondents who would not allow a child to play in their best friend's house if they saw bed bugs. By contrast, less than half of participants reported that they would not allow children to play in a neighbor's house if they saw flies or ants (Table 6). Results were similar regarding neighbors' homes; 884 (84.8%) of participants would not allow children to play in a neighbors' home if they saw a triatomine, relative to 164 (74.2%) for bed bugs, whereas the majority of participants would allow children to play at friends' or neighbors' homes if they saw flies and ants (Table 6). Likewise, participants were most likely to report that they would tell friends and neighbors if they saw a triatomine in the home, relative to other insect species (Table 6).

The topic of stigma was also explored qualitatively in the FGs. Although there was one mention of a child ashamed to go to school with evidence of bug bites, stigma seemed more associated with not wanting to participate in a triatomine spray campaign due to "shame" associated with having these insects in one's home.

> And why didn't the neighbor want them to fumigate her house?
>
> *I imagine from the shame … at the health post they told her "[This is a]* Chirimacha *[bite]."*
>
> *—Participant, ASA*

Mental, social, and economic concerns from insects. FG participants reported fear and phobia of various insects related to past illnesses, news accounts, and stories. Several reported fear of spiders based on stories of death from spider bites, and again, triatomines were of concern: "That insect [triatomines] gives you so much panic! And above all knowing it can transmit diseases." (ASA)

> *Participant 2: It can kill you, the spider can kill you, that's why I'm afraid of it.*
>
> *Participant 3: Yes, there is a spider that kills you.*
>
> *Participant 4: Yes, it's a black spider. I have heard in the news that it killed a teenager in Camaná … they're venomous.*
>
> *—CC*

Insects may also lead to a significant economic burden by causing damage to property, either directly or in the process of attempting to eliminate them; a few participants gave examples of burning bedding and mattresses to get rid of bed bugs or lice.

> Yes, I have burned them, the bed, the mattress, everything, because I became desperate. I burned everything.
>
> *—Participant, ASA*

DISCUSSION

Focus group participants described a range of issues associated with insects, including illness from triatomines, injury from spider bites, economic loss from bed bugs, and fear and stigma leading, in some cases, to avoidance of home fumigation. Insect infestation was associated with behavioral or individual factors such as home cleanliness, neighborhood characteristics such as presence of animals nearby (including chickens, pigs, and guinea pigs), and environmental factors such as the season and climate change. The participants' observations in this study reveal a population that is aware of insects in their environment and how insect dynamics change spatially and temporally.

A majority of survey participants named Chagas disease as transmitted by triatomines, and FG participants reported knowledge of Chagas disease, including the need to seek medical attention and the progression of the disease. Participants reported that Chagas disease was present in their communities, that there were increasing populations of triatomine insects, and that the insects were associated with domestic animals and *bloqueta* (likely cinder block) housing; all of these observations are consistent with literature regarding triatomine ecology and Chagas disease in periurban Arequipa.[2–4,7] Participants' personal experience with triatomines and Chagas disease reinforce the need for ongoing public health efforts against triatomines in this region; there are still gaps in education as evidenced by a significant proportion of survey participants (41.2%) who did not know what diseases were transmitted by triatomines or believed that they did not transmit disease.

Spider bites were mentioned by multiple participants; bites from the species *Loxosceles laeta*, the Chilean recluse spider, pose the greatest medical burden of all venomous spider bites in Peru and can be fatal.[14] Human epidermal parasitic infections such as scabies (mites), pediculosis (lice), and tungiasis (fleas) can also cause pain and discomfort, exposure to pathogenic bacteria, and psychological and social impacts.[15,16] Some of the participants' responses are also consistent with literature showing that bed bugs may cause skin rashes and anaphylaxis through bites, and also have other impacts, including sleep disturbances and posttraumatic stress disorder–like emotional symptoms.[28–30] Replacing items that have been destroyed in response to lice or bed bugs can present as a significant economic burden for people.

Fear of insects was mentioned, with spiders and triatomines seen as the most dangerous due to their ability to cause disease or death. The social concern from certain dangerous insects elicited a behavioral change in some participants. Fear of triatomines, in particular, might be associated with changes in social behavior; a majority of FG participants expressed reservations about allowing children to play in homes of friends or neighbors where triatomines have been seen. When we compared responses, the difference between triatomines and flies or other insects remained notable, indicating this opinion is not generalizable to other insects but is specific to triatomines. Fear about hygiene concerns associated to infestations was also brought up, in which the message that disease can originate from insects in the home may be viewed as a challenge to the perception of the home as clean and hygienic.[31] In this study, insects were associated with a lack of cleanliness in general, with examples in their language; one participant said that she thought her neighbor did not want to participate in a *chirimacha* spray campaign "from shame" (ASA). Regarding triatomine campaigns in particular, it will be important to minimize any shame related to participation in future public health campaigns through community partners and possibly emphasizing that vectors are inherently drawn to human hosts[32] and the presence of vector insects in the home does not reflect a failure of hygiene.

The participants' perceptions of temporal variations in local mosquito and triatomine populations corresponding to seasonal, climatic, and social changes reflect larger trends in vector populations that may require further attention. In particular, FGs in both ASA and CC identified a growing population of a new, small, yellow, fiercely biting fly. Additional species not previously endemic to this area, such as *Aedes aegypti*, could soon appear as well. Nevertheless, it is important to be aware and alert of the possibility of changing vector populations, and related vector-borne diseases, in previously low-risk areas, including peri-urban Arequipa, for mosquito-borne disease.

This study should be seen in the context of some limitations. The survey was conducted before the qualitative portion of the study, and some responses were difficult to understand. Certain survey questions designed to examine stigma did not yield specific enough responses to be useful. Future research about perceptions of insects in Arequipa should focus on the level of stigma associated with infestations of medically important and nuisance insects; in conjunction with our findings, a greater understanding of the stigma associated with each insect, as well as fumigation, could inform the design of future surveillance and vector-control interventions. Another limitation was the nomenclature issues related to insects: people called guinea pigs "guinea pigs," but also called them "rabbits"; cockroaches were identified as "dirty," and yet many confused beetles with cockroaches; the recently seen "biting, yellow mosquito" was actually a fly. Members of our research team from the region helped provide context to what we were hearing from respondents.

CONCLUSIONS

Insects in and around the home present a wide variety of issues to residents of peri-urban Arequipa, including injury, illness, social stigma, and potential economic impacts from addressing the infestations. Future directions include continuing to improve public health education about triatomines and their association with Chagas disease, assessing the possible emergence of mosquito-borne diseases, and developing strategies to address other challenges with insects including bed bug infestations. The wide spectrum of psychological, physical, and environmental impacts should be considered when prioritizing public health interventions related to household insects. Recognizing that both disease and nuisance insects are a burden to the community, future programs can leverage participants experience to adopt a more holistic approach and address both types of insect to increase participation in IRS spray campaigns and other vector control programs.

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