American cutaneous leishmaniasis (ACL) is an increasing public health concern in the New World. Disease burden is primarily concentrated in the most socially excluded populations of Panama, a pattern common in Central America. In Panama ACL control is focused on the clinical treatment of human patients with skin lesions, without considering active surveillance and sand fly control. Nevertheless, the increased evidence for domiciliary and peridomestic transmission calls for improving current vector control strategies.

Here, we present results from an epidemiological survey of 94 people from 24 households in Trinidad de Las Minas, western Panama. We studied the role of sand fly abundance, housing quality, peridomicile landscape matrix, and vegetation structure on shaping household clinical ACL rate patterns at Trinidad de Las Minas. We found that sand fly abundance was significantly associated with household clinical ACL rates, with a 6% rate increase for each additional Lutzomyia gomezi sand fly found inside a domicile.

### Abstract.

American cutaneous leishmaniasis (ACL) transmission patterns have been increasingly associated with domestic and peridomestic environments. Here, we present results from an epidemiological survey of 94 people from 24 households in Trinidad de Las Minas, western Panama. We studied the role of sand fly abundance, housing quality, peridomicile landscape matrix, and vegetation structure on shaping household clinical ACL rate patterns at Trinidad de Las Minas. We found that sand fly abundance was significantly associated with household clinical ACL rates, with a 6% rate increase for each additional Lutzomyia gomezi sand fly found inside a domicile.
Model selection for the best entomological variable associated with household clinical American cutaneous leishmaniasis rates at Trinidad de Las Minas, Panama*

<table>
<thead>
<tr>
<th>Entomological variable</th>
<th>AIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domiciliary sand fly abundance, DSFA (all species)</td>
<td>69.96</td>
</tr>
<tr>
<td>DSFA Lu. panamensis</td>
<td>72.49</td>
</tr>
<tr>
<td>DSFA Lu. gomezi</td>
<td>69.76</td>
</tr>
<tr>
<td>DSFA Lu. Trapidoi</td>
<td>70.97</td>
</tr>
<tr>
<td>Peridomestic sand fly abundance, PSFA (all species)</td>
<td>70.98</td>
</tr>
<tr>
<td>PSFA Lu. panamensis</td>
<td>73.46</td>
</tr>
<tr>
<td>PSFA Lu. gomezi</td>
<td>73.73</td>
</tr>
<tr>
<td>PSFA Lu. trapidoi</td>
<td>73.78</td>
</tr>
</tbody>
</table>

*AIC indicates the Akaike information criterion of each model. Minimum AIC is bolded.

for the presence of the different variables. We then fitted PRGLMs for different parameter combinations (including interactions and independent effects) of the first pc for DI, PI and EI with either: total (i.e., domiciliary + peridomestic, SFA), domiciliary (DSFA), and peridomestic (PSFA) sand fly abundance (which was defined as the average of the three trap nights during which sand flies were collected). After a process of model selection we found that infections were primarily associated with domiciliary sand fly abundance (Supplementary online information, Table S1). Further model selection (Table 1), considering the abundance of the three most dominant vector species in this sample: *Lutzomyia panamensis*, *Lutzomyia gomezi*, and *Lutzomyia trapidoi* (together these species accounted for over 60% of the 2,613 sand flies we caught in the total 144 trap-nights), showed that *Lu. gomezi* had the best association with household clinical ACL rates, where each additional sand fly found inside a house increased by 6% the rate of people with clinical ACL symptoms (Table 2). This model also met all the assumptions of the PRGLM and the residuals were not spatially autocorrelated (Moran’s I = −0.051, P > 0.511), thus warranting statistically valid inferences.

Our observations emphasize patterns already described in Panama, and expected in light of the fundamental role vectors play on the transmission of *Leishmania* spp. parasites, where the abundance of sand flies is closely associated with clinical *Leishmania* infections, even considering the potential bias introduced by the clinical diagnosis. Similar patterns have reported elsewhere in Latin America, particularly associated with household clinical ACL rates, has previously been reported as major vector in Panama, and Latin America.

In recent years an average of 2,188 clinical ACL cases have been reported in Panama, although a 50% underestimation in this number is highly likely. Interestingly, during the first 6 months of 2012 a significant increase in ACL cases was reported in the western region of the province of Panama, where Trinidad de Las Minas is located. During this period more than 500 new cases (50% of them in children < 5 years of age) were officially reported, approximately twice the annually expected number in this region. The possible causes of these “hot spots” are unclear, and may be related to emerging ecological and environmental changes.

We are currently analyzing our vector samples to determine parasite infection rates and to evaluate insecticide thermal fogging impacts on sand fly abundance at Trinidad de Las Minas, in studies subsequent to this one. Nevertheless, the association of sand fly abundance with clinical ACL household rates highlights the need to better understand the ecology of sand flies, for example, which factors underpin the domiciliary abundance, and also for the development of new strategies for phlebotomine sand fly control.

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Note: Supplemental table appears at www.ajtmh.org.

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