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Household use of insecticide consumer products in a dengue endemic area in México

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Abstract

Objectives—To evaluate household use of insecticide consumer products to kill mosquitoes and other insect pests, as well as the expenditures for using these products, in a dengue endemic area in México.

Methods—A questionnaire was administered to 441 households in Mérida City or other communities in Yucatán State to assess household use of insecticide consumer products.

Results—Most (86.6%) households took action to kill insect pests with consumer products. Among those households, the most commonly used product types were insecticide aerosol spray cans (73.6%), electric plug-in insecticide emitters (37.4%), and mosquito coils (28.3%). Mosquitoes were targeted by 89.7% of households using insecticide aerosol spray cans and >99% of households using electric plug-in insecticide emitters or mosquito coils. During the part of the year when a given product type was used, the frequency of use was daily or every 2 days in most of the households for insecticide aerosol spray cans (61.4%), electric plug-in insecticide emitters (76.2%), and mosquito coils (82.1%). For all products used to kill insect pests, the median annual estimated expenditure per household that took action was 408 Mexican pesos ($MXN), which corresponded to ∼31 $U.S. These numbers are suggestive of an annual market in excess of 75 million $MXN (>5.7 million $U.S.) for Mérida City alone.

Conclusion—Mosquitoes threaten human health and are major nuisances in homes in the study area in México. Households were found to have taken vigorous action to kill mosquitoes and other insect pests and spent substantial amounts of money on insecticide consumer products.

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Introduction

In a previous study on the effectiveness of insecticide-treated window curtains to prevent entry into homes in Mérida City, Yucatán State, México by the dengue virus mosquito vector *Aedes aegypti*, we reported common household use of insecticide consumer products to kill mosquitoes: aerosol spray cans with insecticide were used to kill mosquitoes in ∼70% of homes, and insecticide emitters were used in 10–20% of homes (Loroño-Pino*et al.* 2013). This heavy use of insecticide consumer products is not surprising in light of our previous reports of large numbers of *Ae. aegypti* and another human-biting mosquito, *Culex quinquesfasciatus*, being present in homes in Mérida City (García-Rejón *et al.* 2008; Loroño-Pino *et al.* 2013). Other studies have reported use of insecticide consumer products for 28–89% of households in dengue endemic settings in Asia (van Benthem *et al.* 2002; Itrat *et al.* 2008; Syed *et al.* 2010; Naing *et al.* 2011; Al-Dubai *et al.* 2013; Mayxay *et al.* 2103) or the Americas (Shuaib *et al.* 2010). However, details are very scarce in these and our previous publication with regards to the extent of insecticide consumer product use – e.g., how often and in which parts of the home they are used – and the amount of money spent on the products. This is unfortunate because, as shown by a recent study from a malaria-endemic area in Africa, much can be learned from in-depth assessments of household use of pest control products (Nalwanga and Ssempebwa 2011). Moreover, there are potential negative health effects, particularly for asthma and respiratory diseases, from inhalation of pesticide aerosols or vapors (Hernandez *et al.* 2011).

Improved knowledge of the extent of household use of insecticide consumer products is important not only to determine the willingness of households to invest in the use of domicile-targeted insecticide-based products – to kill mosquitoes, cockroaches, and other indoor pests – but also to help assess the overall insecticide exposure in the environment stemming from household use, vector control program applications to suppress mosquitoes or other arthropods spreading pathogens to humans or domestic animals, and agricultural applications to protect crops. Here, we report on a study aiming to generate detailed knowledge of household use of insecticide consumer products to kill mosquitoes and other common household insect pests, and the expenditures for using these products, in the dengue hyper-endemic Yucatán State, México.

Methods

Study area and study population

The study was conducted in Yucatán State in southern México. This subtropical area is hyper-endemic for dengue – with co-circulation of multiple dengue virus (DENV) serotypes – with *Aedes aegypti* being the primary local mosquito vector for DENV (Loroño-Pino *et al.* 2004, 2013; García-Rejón *et al.* 2008, 2011). Study communities included Mérida City, which is the major urban center in Yucatán State, two of this city's adjacent satellite communities (Caucel and Umán), and three more rural outlying communities (Hunucmá, Maxcanú, and Motul) located 20–50 km from Mérida City (Figure 1). The grouping of Mérida City, Caucel, and Umán is hereafter referred to as the urban area; the grouping of Hunucmá, Maxcanú, and Motul is referred to as the rural area.

Across these communities, we recruited clusters of households to participate in a study aiming to determine the protective effect of insecticide-treated window curtains against intrusion by *Ae. aegypti* in relation to the local insecticide resistance profile for this mosquito. Paired clusters of study homes were to receive insecticide-treated window curtains or similar but non-treated window curtains, respectively, in September 2012. The results reported here are based on a questionnaire administered in 441 households in July–August 2012 – before the homes received window curtains – to generate detailed baseline knowledge of household use of insecticide consumer products and the expenditures for their use. Of the 441 study households, 350 were located in the urban area (294 in Mérida City, 17 in Caucel, and 39 in Umán) and 91 in the rural area (18 in Hunucmá, 36 in Maxcanú, and 37 in Motul). Study households in Mérida City were spread across multiple neighborhoods in the western and eastern parts of the city. The study participant answering the questionnaire on behalf of the household most commonly was female (87%). Approximately 62% of the respondents reported working in the home or being retired versus 38% working or studying outside of the home. The vast majority of study homes were one story cement block buildings equipped with electricity and running water but lacking central air conditioning.

Study questionnaire

The questionnaires were administered (in Spanish) in person during home visits by professional anthropologists (co-authors Chan-Dzul and Zapata-Gil) or a professional nurse (co-author Carrillo-Solís) trained by the anthropologists in administering the questionnaire. The questionnaire content was informed by our previous study in Mérida City (Loroño-Pino *et al.* 2013) and through pre-study visits to households in the area by the anthropologists to gather preliminary information about actions taken to kill household insect pests. Administering the questionnaire typically took between 20–40 minutes, depending on the need to clarify questions to the respondents and the amount of information they shared. The full questionnaire is available as supplementary online material, in the original Spanish version and as an English translation.

The initial question was: Is anyone in the family doing something to kill insect pests (like mosquitoes, flies, cockroaches, ants, or termites) either inside or outside the home (Yes or No)? If the answer was No, a single follow-up question determined the reason for not taking action. If the answer was Yes, the questions outlined below were pursued. A first set of questions focused on the specific methods/product types used to control insect pests (insecticide aerosol spray can, electric plug-in insecticide emitter, mosquito coil, smoke, electric insect racquet, candle, and/or other methods); the brand names and brand name varieties of the products used; and what type of pests for which a specific product type was used (mosquitoes, flies, cockroaches, ants, termites, scorpions, and/or other pests).

To ensure that product types and brand varieties of consumer products were remembered correctly by the respondents, the householders were asked to show the products they used and also to pick them out from a product catalogue designed by the anthropologist/nurse team specifically for this purpose. This product catalogue showed color images of 63 locally marketed products, including 35 brand varieties of insecticide aerosol spray cans, 15 brand

varieties of electric plug-in insecticide emitters, 10 brand varieties of mosquito coils, one electric insect racquet, and two types of candles.

A second set of questions focused on: when the products were used (year around, only during the rainy season, only when there are mosquitoes, or other times); how frequently, as well as how many of, the products were purchased and used (every day, every 2 days, once a week, once every 15 days, once per month, or other options); the approximate cost per item; and where the products were purchased (small store, supermarket, street salesperson, and/or other options). An additional question determined if the householder followed the manufacturer's instructions for use of a given product (Yes, No, or I don't know). Based on their additional verbal description of the product's use in the household, the anthropologist/nurse team then classified each product's use as correct or incorrect. Correct use of an insecticide aerosol spray can entailed: 1) closing windows and doors, covering food, and moving people and pets outdoors; 2) shaking the spray can before applying the insecticide aerosol and then allowing 20 minutes before opening windows and doors and going back indoors; 3) applying the insecticide aerosol directly over the insects to the extent possible; and 4) applying the insecticide aerosol in corners and under or inside furniture, moving from the interior of the home to the exit door. Correct use of an electric plug-in insecticide emitter entailed using the product in a power outlet located close to a window or door that was open at least part of the time to encourage mosquitoes to leave the home. Correct use of a mosquito coil entailed burning it near an open door or window or in an open space such as a patio.

A third set of questions focused on the rooms of the home where the specific methods used to control insect pests were employed (living/dining room, kitchen, bedroom of children less than 18 years of age, bedroom of adults 18 years or older, bathroom, storage room, laundry room, other room type, all rooms in the home, and/or patio/terrace), as well as the reason(s) for use of the product in those room types. Finally, we estimated the total expenditures per year for specific methods/product types to kill household insect pests, as well as for all methods/product types combined. These estimations were based on the answers given for each household for the frequency of purchasing specific products, the numbers of items purchased, and the item cost. The estimated product-specific expenditures were then summed to obtain the total expenditure for a given method/product type (e.g., insecticide aerosol spray cans) and for all products combined in each household.

Data management and statistical analysis

Field-collected data were entered into a REDCap (Research Electronic Data Capture) database (Harris *et al.* 2009) and were exported to Microsoft Excel (Microsoft Corporation, Redmond, Washington) prior to data analysis. Statistical analyses were carried out using the JMP® statistical package (Sall et al. 2005), and results were considered significant when $P < 0.05$.Differences in the percentage of households that engaged in a specific activity were compared statistically using the likelihood ratio chi-square test within contingency table analysis. Data on household expenditures for the use of insecticide consumer products were highly skewed and therefore were compared statistically using the Wilcoxon rank-sum test;

application of the two-sample t-test to log-transformation of these data produced statistically similar results (not shown).

Human subjects research approval

The study was approved by the Bioethics Committee of Centro de Investigaciones Regionales Dr. Hideyo Noguchi, Universidad Autónoma de Yucatán, and the Institutional Review Board of Colorado State University.

Results

Percentage of households taking action to kill insect pests and methods used

For all 441 study households combined, 86.6% took action to kill insect pests – such as mosquitoes, flies, cockroaches, ants, or termites – inside or outside the home (Table 1). The percentages of households taking such action were similar for the urban area and the rural area (85.7% and 90.1%, respectively) (Table 1). Among the 59 households not taking action to kill insect pests, the most prominent specific reasons given were that no mosquitoes were found inside the home (25), that residents had allergies (22), or that the home had window screens (9).

For the 382 households that took action to kill household insect pests, the most commonly used method was insecticide aerosol spray cans (73.6%), followed by electric plug-in insecticide emitters (37.4%) and mosquito coils (28.3%) (Table 1). Other methods reported less frequently included burning various items (e.g., egg cartons, herbs, or wood) to produce smoke, use of electric insect racquets or citronella candles, or physically killing mosquitoes by hitting them with various objects. Insecticide aerosol spray cans were used by a greater percentage of households in the urban area as compared with the rural area (79.3% and 52.4%; $P < 0.001$), whereas use of electric plug-in insecticide emitters was more prevalent in the rural area than in the urban area (53.7% and 33.0%; $P < 0.001$) (Table 1). The use of mosquito coils was similar between the community groupings.

With regards to the household insect pest for which a specific type of product was used, mosquitoes were named by 89.7% of 281 households using insecticide aerosol spray cans, 99.3% of 143 households using electric plug-in insecticide emitters, and all households using mosquito coils, smoke, or electric insect racquets. Insecticide aerosol spray cans were used extensively against mosquitoes by households in the urban area (89.1%), as well as in the rural area (93.0%).They also were used against other household insect pests, including cockroaches (73.3% of households using insecticide aerosol spray cans), ants (36.7%), and flies (29.2%). %). Percentages of households using insecticide aerosol spray cans against specific pests were similar ($P > 0.05$) between the urban and rural households.

Based on the assessment by the anthropologist/nurse team of the descriptions given by respondents for how they employed a given product type, the use was classified as correct for 88.9% for insecticide aerosol spray cans, compared to 64.9% for mosquito coils, and only 42.3% for electric plug-in insecticide emitters.

Timing of actions to kill household insect pests for the most commonly used methods

Of the households that used a specific method, 69.5% reported using insecticide aerosol spray cans year around, 46.3%reported using electric plug-in insecticide emitters year around, and 47.6% reported using mosquito coils year around (Table 2).The remaining households used these products only seasonally (during the rainy season) or sporadically (when mosquitoes or other insect pests were seen).Year around use of insecticide aerosol spray cans was reported for 71.1% of households in the urban area and 60.0% of households in the rural area (Table 2). Corresponding year around use of electric plug-in insecticide emitters or mosquito coils were reported for 44.0% and 46.8%, respectively, of households in the urban area versus 51.2% and 50.0%, respectively, of households in the rural area (Table 2). There were no statistically significant differences between urban and rural households in the likelihood of using insecticide aerosol spray cans, electric plug-in insecticide emitters, or mosquito coils year around versus only during parts of the year ($P > 0.05$).

During the time period when a given method was used, the reported frequency of use for all study homes combined was either daily or every 2 days in 61.4% of households for insecticide aerosol spray cans, 76.3%of households for electric plug-in insecticide emitters, and 82.1% of households for mosquito coils (Table 2). The corresponding percentages for use either daily or every 2 days in households in the urban area or the rural area were 59.1% and 73.8%, respectively, for insecticide aerosol spray cans, 70.5% and 88.6%, respectively, for electric plug-in insecticide emitters, and 82.5% and 80.8%, respectively, for mosquito coils (Table 2). Use of electric plug-in insecticide emitters either daily or every 2 days was more prevalent in the rural area than in the urban area ($P = 0.014$), whereas there were no statistically significant differences between the urban and rural areas for the other methods.

Intradomicile and outdoor patio use patterns for the most commonly employed methods to kill household insect pests

The pattern of intradomicile and outdoor patio use of insecticides varied by method, as well as between urban and rural households. For all study households combined, insecticide aerosol spray cans were used most commonly in bedrooms (88.6%) but were also used extensively in bathrooms (74.4%), living/dining rooms (69.8%), and kitchens (61.9%) (Table 3). Use of insecticide aerosol spray cans in the outdoor patio was sporadic (6.0%). Electric plug-in insecticide emitters were used commonly in bedrooms (81.1% of households), to a lesser extent in living/dining rooms (44.8%), only rarely in kitchens or bathrooms (<15%), and not in the outdoor patio (Table 3). Mosquito coils were used commonly in living/dining rooms (68.5% of households) and bedrooms (49.1%), but less frequently in kitchens (31.5%), bathrooms (15.7%), or outdoor patios (13.0%) (Table 3).

The likelihood of insecticide aerosol spray cans being used in a given room type in households was similar in the urban and rural area households for bedrooms and bathrooms ($P \geq 0.292$) but was higher in the rural area for living/dining rooms ($P = 0.023$) and kitchens ($P = 0.003$) (Table 3). The likelihood of electric plug-in insecticide emitters being used in a given room type in households in the urban area was similar to that in rural area households for living/dining rooms ($P = 0.117$), was higher in the urban area for bedrooms ($P = 0.035$),

but was higher in the rural area for kitchens and bathrooms ($P \leq 0.013$).The likelihood of mosquito coils being used in a given room type in households was similar in the urban and rural areas for bedrooms, living/dining rooms, and kitchens ($P \geq 0.180$) but was higher in the rural area for bathrooms ($P = 0.023$). For outdoor patios, households in the urban area were more likely to use insecticide aerosol spray cans than rural area households ($P = 0.016$), whereas the likelihood of using mosquito coils was similar between urban and rural households ($P = 0.335$).

Expenditures for actions to kill household insect pests

For all methods used to kill household insect pests combined, the median annual estimated expenditure per household that took action was 408 Mexican pesos ($MXN) (Table 4). Using a conversion rate of 1 $U.S. to 13.30 $MXN for July, 2012 when the survey was undertaken, this corresponded to ∼31 $U.S. The median annual expenditure per household was significantly ($P = 0.028$) higher in the rural area (453 $MXN) than in the urban area (384 $MXN) (Table 4). For all households combined, 69.4% were estimated to spend>200 $MXN (>15 $U.S.) per year on products to kill insect pests, 39.0% were estimated to spend >500 $MXN (>37 $U.S.) per year, and 17.5% were estimated to spend >1,000 $MXN (>75 $U.S.) per year (Table 4). The likelihood of households spending >200 $MXN or >500 $MXN per year on products to kill insect pests were similar between the community groupings, whereas a significantly ($P = 0.036$) higher percentage of households in the rural area reported spending >1,000 $MXN per year. In Table 4, we also present similar summary statistics on annual expenditure for insecticide aerosol spray cans, electric plug-in insecticide emitters, or mosquito coils separately.

Discussion

Our most important findings were that the vast majority (87%) of households in a dengue endemic area in México take vigorous action to kill mosquitoes and other household insect pests and that a substantial amount of money (median annual estimated expenditure per household of 408$MXN) was spent on insecticide consumer products to control nuisance insects and pathogen vectors. Our data indicate that the market for insecticide consumer products is substantial both in urban and rural settings in dengue endemic areas in México. For example, Mérida City alone includes ∼230,000 households (based on data for 2010 from Instituto Nacional de Estadística y Geografía). Based on a median annual estimated expenditure per household that takes action to kill insect pests in this urban area of 384 $MXN, and with 86% of all households taking action, the annual market for insecticide consumer products exceeds 75 million $MXN(>5.7 million $U.S.) in Mérida City alone. To the best of our knowledge, this is the first study to provide a detailed description of household insecticide consumer product use in a dengue endemic setting and to estimate the household expenditure for these products. The main weakness of the study is the usual problem in any retrospective survey – that is, recalling actions taken over a long time period (1 year). To minimize recall bias, the questionnaires were administered in person during home visits. This practice allowed for clarification of questions that were confusing to some of the respondents, as well as for the individuals administering the questionnaire to aid the respondents in recalling their actions as accurately as possible.

The extensive use of household insecticide consumer products in the study area likely is related, in large part, to heavy infestation of homes by human-biting mosquitoes, most notably the dengue virus vector *Ae. aegypti* and the nuisance-biter *Cx. quinquefasciatus*. During the rainy season, single households can harbor very large numbers – sometimes > 100 – of these mosquitoes (García-Rejón *et al.* 2008; Loroño-Pino *et al.* 2013). Our main findings likely are relevant across much of the American subtropics and tropics where socioeconomic conditions are comparable to México. As a case in point, a study from the dengue endemic island of Jamaica in the Caribbean reported use of insecticide sprays by 62% of households, without giving further details of use or cost (Shuaib *et al.* 2010). In our study area, mosquitoes were the most important targets for use of insecticide aerosol spray cans, as well as electric plug-in insecticide emitters and mosquito coils. Insecticide aerosol spray cans also were used commonly to kill cockroaches, ants, and flies. Occasionally reported non-standard use of the products included splitting mosquito coils into multiple pieces to be burned in different rooms, using individual electric plug-in insecticide emitters longer than recommended, or burning the portion of the emitter containing the insecticide after it had been used.

The common year around use of insecticide consumer products to kill mosquitoes, most often with applications daily or every 2 days, as observed in this study (Table 2), is consistent with our previous findings that mosquitoes infest homes in the study area year around (García-Rejón *et al.* 2008; Loroño-Pino *et al.* 2013). Likewise, the extensive use of insecticide consumer products, particularly insecticide aerosol spray cans and electric plug-in insecticide emitters, in bedrooms (Table 3) is consistent with our previous studies showing that this room type is where most of the mosquitoes are found (García-Rejón *et al.* 2008; Loroño-Pino *et al.* 2013). The percentages of households taking action to kill household insect pests were high (> 85%) in both the urban area and the rural area, and most households in both settings used insecticide consumer products year around and with high frequency. However, we found some notable differences between the urban and rural areas. Households in the urban area were more than twice as likely to use insecticide aerosol spray cans compared with electric plug-in insecticide emitters, where as the extent of use was similar for these product types in the rural area (Table 1). These different use patterns could result from variable access to products in the urban and rural areas or to difference in cost per product item. We also found that the intensity of use and expenditures for insecticide consumer products were greater in the rural area (Table 4). Despite being used in a lower percentage of households (Table 1), the median annual estimated expenditure for use of insecticide aerosol spray cans per household (Table 4) was greater in the rural area than in the urban area (420 and 324 $MXN, respectively). Moreover, the median expenditure per household for electric plug-in insecticide emitters was more than twice as high in the rural area than in the urban area (584 and 180 $MXN, respectively). The most likely explanation for the more intensive use of insecticide consumer products in the rural area – with very high percentages (> 95%) of households using insecticide consumer products at least weekly (Table 2) and application often including most room types (Table 3) – is that household insect pests are more prevalent and abundant in the rural area compared with the urban setting.

One important but poorly understood issue is to what extent household use of insecticide consumer products may contribute to build-up of insecticide resistance in local mosquito populations. Although our study cannot answer this question, we nevertheless documented extensive household use of specific products (brand varieties) containing pyrethroid insecticides in insecticide aerosol spray cans (allethrin, cyfluthrin, cypermethrin, cyphenothrin, imiprothrin, permethrin, prallethrin, tetramethrin, and/or transfluthrin), electric plug-in insecticide emitters (allethrin), and mosquito coils (allethrin or transfluthrin). Of 25 total products reported to be used commonly (by ≥10 households) in the study area, only one brand variety of insecticide aerosol spray can contained a non-pyrethroid insecticide, the carbamatepropoxur (in combination with the pyrethroid cyfluthrin). Four other rarely used (by ≤5 households) brand varieties of insecticide aerosol spray cans also contained propoxur in combination with pyrethroids or with a pyrethroid and the organophosphate dichlorvos. The nearly exclusive use of pyrethroid insecticides in household consumer products is problematic because we previously demonstrated that *Ae. aegypti* from Mérida City have become strongly knock-down resistant to pyrethroid insecticides (Ponce-García *et al.* 2009, Loroño-Pino*et al.* 2013). We therefore speculate that use of available insecticide consumer products in Mérida City has limited effectiveness to kill the dengue virus vector *Ae. aegypti*. Research is urgently needed to address this important issue.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Figure 1.

Location of study communities in Yucatán State in southernMéxico, and of study neighborhoods in the western and eastern parts of Mérida City (shaded areas).

Table 1

Percentage of households taking action to kill household insect pests inside or outside the home, and the methods most commonly used by those taking action.

	All study households		Urban area		Rural area	
	Number	**%**	**Number**	**%**	**Number**	**%**
Action taken to kill household insect pests (e.g., mosquitoes, flies, cockroaches, ants, or termites)						
Number of households	*441*		*350*		*91*	
Yes	382	86.6	300	85.7	82	90.1^{NS}
No	59	13.4	50	14.3	9	9.9^{NS}
Methods used to control household insect pests (a household can report use of >1 method)						
Number of households	*382*		*300*		*82*	
Insecticide aerosol spray can	281	73.6	238	79.3	43	52.4***
Electric plug-in insecticide emitter	143	37.4	99	33.0	44	53.7***
Mosquito coil	108	28.3	82	27.3	26	31.7^{NS}
Smoke	19	5.0	15	5.0	4	4.9^{NS}
Electric insect racquet	11	2.9	10	3.3	1	1.2^{NS}

The statistical significance for the observed differences between the urban area and the rural area are indicated as follows: $P > 0.05^{NS}$;

$^{*}P \leq 0.05$;

$^{**}P \leq 0.01$;

$^{***}P \leq 0.001$.

Table 2

Timing of actions to kill household insect pests for the most commonly used methods.

	All responding study households		Urban area		Rural area	
	Number	%	Number	%	Number	%
Part(s) of the year when insecticide aerosol spray cans were used						
Number of households	*272*		*232*		*40*	
Only during the rainy season	40	14.7	28	12.1	12	30.0
Only when there are mosquitoes	43	15.8	39	16.8	4	10.0
Year around	189	69.5	165	71.1	24	60.0[NS]
Frequency of use of insecticide aerosol spray cans						
Number of households	*277*		*235*		*42*	
Daily	72	26.0	60	25.5	12	28.6
Every 2 days	98	35.4	79	33.6	19	45.2
Once per week	68	24.5	59	25.1	9	21.4
Less often than weekly	39	14.1	37	15.7	2	4.8
Part(s) of the year when electric plug-in insecticide emitters were used						
Number of households	*134*		*91*		*43*	
Only during the rainy season	39	29.1	24	26.4	15	34.9
Only when there are mosquitoes	33	24.6	27	29.7	6	13.9
Year around	62	46.3	40	44.0	22	51.2[NS]
Frequency of use of electric plug-in insecticide emitters						
Number of households	*139*		*95*		*44*	
Daily	57	41.0	31	32.6	26	59.1
Every 2 days	49	35.3	36	37.9	13	29.6
Once per week	17	12.2	13	13.7	4	9.1
Less often than weekly	16	11.5	15	15.8	1	2.3
Part(s) of the year when mosquito coils were used						
Number of households	*105*		*79*		*26*	
Only during the rainy season	33	31.4	21	26.6	12	46.2
Only when there are mosquitoes	22	21.0	21	26.6	1	3.9
Year around	50	47.6	37	46.8	13	50.0[NS]

	All responding study households		Urban area		Rural area	
	Number	%	Number	%	Number	%
Frequency of use of mosquito coils						
Number of households	*106*		*80*		*26*	
Daily	47	44.3	31	38.8	16	61.5
Every 2 days	40	37.7	35	43.8	5	19.2
Once per week	13	12.3	8	10.0	5	19.2
Less often than weekly	6	5.7	6	7.5	0	0.0

The statistical significance for the observed differences between the urban area and the rural area are indicated for use year around versus only seasonally (noted with the percentage value for year around use) as follows: $P > 0.05^{NS}$;

$^{*}P \leq 0.05$;

$^{**}P \leq 0.01$;

$^{***}P \leq 0.001$.

Table 3

Use of the most commonly employed methods to kill household insect pests in selected room types and the outdoor patio.

	All responding study households		Urban area		Rural area	
	Number	**%**	**Number**	**%**	**Number**	**%**
Parts of the home where insecticide aerosol spray cans were used (a household can report >1 room type)						
Number of households	*281*		*238*		*43*	
Bedroom	249	88.6	210	88.2	39	90.7^{NS}
Living/dining room	196	69.8	160	67.2	36	83.7*
Kitchen	174	61.9	139	58.4	35	81.4**
Bathroom	190	74.4	158	66.4	32	74.4^{NS}
Outdoor patio	17	6.0	17	7.1	0	0.0*
Parts of the home where electric plug-in insecticide emitters were used (a household can report >1 room type)						
Number of households	*143*		*99*		*44*	
Bedroom	116	81.1	85	85.9	31	70.5*
Living/dining room	64	44.8	40	40.4	24	54.5^{NS}
Kitchen	21	14.7	7	7.1	14	31.8***
Bathroom	15	10.5	6	6.1	9	20.5*
Outdoor patio	0	0.0	0	0.0	0	0.0
Parts of the home where mosquito coils were used (a household can report >1 room type)						
Number of households	*108*		*82*		*26*	
Bedroom	53	49.1	38	46.3	15	57.7^{NS}
Living/dining room	74	68.5	56	68.3	18	69.2^{NS}
Kitchen	34	31.5	23	28.0	11	42.3^{NS}
Bathroom	17	15.7	9	11.0	8	30.8*
Outdoor patio	14	13.0	12	14.6	2	7.7^{NS}

The statistical significance for the observed differences between the urban area and the rural area are indicated as follows: $P > 0.05^{NS}$;

$^{*}P \leq 0.05$;

$^{**}P \leq 0.01$;

*** $P \leq 0.001$.

Table 4

Estimated annual expenditures for methods to kill household insect pests.

	All responding study households	Urban area	Rural area
Approximate annual expenditure ($MXN) for all methods combined in households taking action to kill household insect pests			
Number of households	*382*	*300*	*82*
Median expenditure	408	384	453*
Range for expenditure	<10 to 6,173	<10 to 6,173	10 to 4,514
% of households spending >200 $MXN	69.4	68.0	74.4NS
% of households spending >500 $MXN	39.0	37.3	45.1NS
% of households spending >1,000 $MXN	17.5	15.3	25.6*
Approximate annual expenditure($MXN) for use of insecticide aerosol spray cans in households using that method			
Number of households	*281*	*238*	*43*
Median expenditure	336	324	420NS
Range for expenditure	30 to 3,640	30 to 2,400	30 to 3,640
% of households spending >200 $MXN	66.2	65.1	72.1NS
% of households spending >500 $MXN	29.5	29.0	32.6NS
% of households spending >1,000 $MXN	7.5	7.1	9.3NS
Approximate annual expenditure ($MXN) for use of electric plug-in insecticide emitters inhouseholds using that method			
Number of households	*143*	*99*	*44*
Median expenditure	270	180	584***
Range for expenditure	<10 to 3,650	<10 to 1,800	10 to 3,650
% of households spending >200 $MXN	55.2	47.5	72.7**
% of households spending >500 $MXN	35.7	28.3	52.3**
% of households spending >1,000 $MXN	16.8	13.1	25.0NS
Approximate annual expenditure ($MXN) for use of mosquito coils in households using that method			
Number of households	*108*	*82*	*26*
Median expenditure	135	118	140NS
Range for expenditure	<10 to 5,011	<10 to 5,011	24 to 1,460
% of households spending >200 $MXN	36.1	34.1	42.3NS
% of households spending >500 $MXN	12.0	12.2	11.5NS
% of households spending >1,000 $MXN	6.5	6.1	7.7NS

The statistical significance for the observed differences between the urban area and the rural area are indicated as follows: $P > 0.05^{NS}$;

* $P \leq 0.05$;

** $P \leq 0.01$;

*** $P \leq 0.001$.