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means and standard deviations for reported costs of dengue treatment and measured significance of differences in costs between sub-groups using the non-parametric Kruskall-Wallis test. We used a cluster t-test to test for significance of differences of proportions of households with dengue cases and costs of treatment between intervention and control clusters in the follow up survey.

Results

Household costs of treating dengue illness

We analysed data from 12,312 households in the baseline survey. The total number of dengue cases reported in the last 12 months was 1020, representing 1.9% of the sample population. Among these cases, the household respondent reported 6.8% (69/1013) as dengue haemorrhagic fever. The period prevalence was the same in males (1.9%, 485/26,117) and females (1.9%, 535/28,280). Dengue cases were more common in Acapulco region (3.5%; 660/18,997) than in Costa Grande (1.5%; 251/17,063) or Costa Chica (0.6%; 109/18,342).

Most (78%; 752/960) of the reported dengue cases were treated at home or as ambulatory patients; only 22% (208/960) were hospitalized. Rates of hospitalization among the cases were 21.4% (131/612) for Acapulco, 19.5% (47/221) for Costa Grande, and 28% (30/107) for Costa Chica. Ambulatory dengue cases were most commonly treated by the Secretaría de Salud (SSA) (41%, 303/739) and by private physicians (30%, 222/739). Smaller proportions were treated by other government health institutions: Instituto Mexicano del Seguro Social (IMSS) treated 16% (115/739), Instituto de Seguridad y Servicios Sociales de los Trabajadores del Estado (ISSSTE) 3% (24/739), and Secretaría de Defensa Nacional (SEDENA) 0.5% (4/739). Some 3% (22/739) were treated at pharmacies and 6% (45/739) were treated only at home.

The hospitalization rates for dengue cases treated by different health institutions were as follows: IMSS 37% (70/188), SSA 15% (52/388), ISSSTE 40% (16/40), SEDENA 71% (10/14), pharmacy 8% (2/25) and private physician 20% (55/281).

Table 1 shows the reported household costs for ambulatory dengue cases, both cash expenditures and work or school days lost. The mean household expenditure for ambulatory dengue cases was USD 51 (n = 737, SD USD 85.0), with a mean of 10.7 days lost. The lowest expenditure was for those who were treated only at home (USD12.80) and the highest was for cases treated by private physicians (USD 95.50). Those treated at home lost the fewest work/school days (6.5), while those treated at pharmacies lost the most (14.1 days).

Table 2 shows the reported household expenditures for hospitalized dengue cases. The lowest expenditure was reported by those who were hospitalized by SEDENA (USD 28) and the highest was for those hospitalized in private institutions (USD 392). The average number of work or school days lost by patient and caregiver(s) combined was 15.4 (n = 203, SD 8.9). This is higher than the number of days lost by dengue cases that were not hospitalized, who lost an average of 10.7 work or school days (n = 746, SD = 7.6) (Table 1). Of the 55 dengue cases treated as inpatients in private hospitals, only three came from households where the household head was reported as not in formal employment.

Table 3 shows an extrapolation of the figures for work and school days lost from dengue in patients and caregivers in the last 12 months to the whole population of the three coastal regions. This extrapolation is justified on the basis that the urban: rural balance in each region in the study sample is similar to that for the whole population in each region [11].

Impact of the Camino Verde intervention

The follow-up survey included 10,491 households, 5349 from 45 intervention sites and 5142 from 45 reference

sites. Table 4 shows for intervention and control clusters the proportions of households with at least one dengue case, the dengue case rates per 1000 population, the mean work or school days lost due to dengue for patients and caregivers, and the number of days lost per 1000 population. The proportion of households with at least one dengue case in the last 12 months was lower in the intervention clusters; in this Mexican arm of the trial, the difference was significant at the 9% level. The mean number of days of work or school lost by a dengue case or caregiver was not different between intervention and control clusters, but the days lost per 1000 population were less in intervention clusters because of the reduced number of cases.

As shown in Table 4, the Camino Verde intervention resulted in a saving in days lost for dengue patients and caregivers. The saving was 47.46 days per 1000 population for patients and 44.07 days per 1000 population for caregivers – a total of 91.53 days saved per 1000 population. The estimated population for the three coastal regions of Guerrero is 1,632,265: 789,971 in Acapulco, 413,793 in Costa Grande, and 428,501 in Costa Chica [13]. If the intervention were applied to this whole population, it could be expected to save 149,401 days due to dengue illness (1,632,265 × 0.09153).

hospitalized cases. The costs per case were similar between intervention and control clusters, but because of the reduced number of cases, the overall costs for every element were lower for intervention than control clusters.

Discussion

Our study confirms that costs of dengue illness to households are substantial in a dengue endemic area of Mexico, especially when one takes into account work or school days lost. According to the 2012 National Household Income and Expenditure Survey the average monthly income for Mexican households in the lowest income decile was USD185 [14]. Treatment of an ambulatory dengue case by a private physician, for example, would thus consume more than half a month's income (Table 1) and hospitalization in a private facility would require more than two month's income from households in this income range, even when not taking into account the full cost to the patient of a private hospital stay (Table 2). These costs are in addition to the loss of 17 workdays which, to lower-income families, can be much more devastating than to those with steadier employment and benefits packages.

In a separate analysis of expenditures on insecticide anti-mosquito products reported in our 2012 impact survey, we found a monthly expenditure of USD6.00 in intervention communities and USD6.83 in reference communities, which represents 3.3% and 3.8% respectively of monthly income for the poorest 10% of the population in 2012 [15].

In 2009 Suaya and colleagues examined the costs of dengue illness in eight countries of Asia and the Americas. Days lost from school or work for non-hospitalised dengue patients and those who took care of them are similar in our study to those reported by Suaya in Guatemala, Venezuela and Malaysia and those reported by the same authors in Guatemala and Malaysia are similar to ours, for patients who went to private hospitals [7].

Undurraga et al. reported higher costs than ours, for hospitalised and non-hospitalised dengue patients [8]. The difference might be because they took into account costs to the government for the health services they provide, and monetized indirect costs, whereas we did not include government services costs and did not monetize indirect costs. Also, our costs for hospitalized cases are under-estimates because they do not include costs beyond consultation, medicines and transport. This is particularly relevant for private hospital stays, for which the total costs to the patients will be much higher than USD392.

The costs of dengue reported by Castro and colleagues from Colombia for both hospitalised and non-hospitalised dengue cases were lower than we found in Mexico [9]. The difference could be because 96% of Colombians in 2011 were covered by some form of health insurance, whereas in our study in Mexico, 28%

Dengue is just one illness that can befall a household in any given year. Many researchers have examined the burden to households of costs associated with illness in general and the care received for it [17]. In 2006 McIn-

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JLS participated in the design of the Camino Verde trial, wrote the original Spanish draft of this article and oversaw its final English draft; SPS, AMP and ENA participated in the design of the Camino Verde trial and contributed to the Spanish draft; FRS and DLDG contributed to the Spanish draft, RJL participated in the design of the Camino Verde trial and contributed to both the Spanish and English drafts, AC contributed to revision and finalization of the English draft, and NA was principal investigator of the Camino Verde trial in Mexico and participated in both the Spanish and English drafts. All authors read and approved the final manuscript

Competing interests
The authors declare that they have no competing interests.

Consent for publication
Not applicable.

Ethics approval and consent to participate
This study was approved by the CIET Canada research ethics board (16 November 2009) and the ethics committee of the at the (27 November 2009). Both boards performed annual review and gave approval throughout the study. All participants gave verbal informed consent.

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