Summary
During the dengue outbreak that struck Santiago de Cuba in 2006–2007, we conducted an observational study in the Mariana Grajales district, the former setting of a community trial for Aedes aegypti control. In the trial, community working groups (CWG) had been created in 29 randomly selected intervention house blocks, and routine vector control activities alone were conducted in the remaining 30 control blocks. The CWG elaborated and implemented with the population plans and activities to reduce Aedes infestation. They were still functional in 2006 and continued organizing community-based environmental management activities. The attack rate of dengue fever during the outbreak was 8.5 per 1000 inhabitants in the former intervention blocks and 38.1 per 1000 inhabitants in the control blocks, which corresponds to a relative risk of 4.5 (95% CI 3.1–6.5). There was a significantly higher proportion of unaffected intervention blocks, and affected blocks had on average substantially less cases than affected control blocks. This study indicates that community-based environmental management inserted in the routine A. aegypti control programme can not only sustainably curb vector infestation but also have an impact on dengue transmission.

**Keywords**
dengue, vector control, community-based strategies, outbreak, Cuba

Introduction
Dengue virus continues its spread throughout the world and causes an increasing health and economic burden. Recent estimates exceed 36 million dengue fever and 2.1 million dengue haemorrhagic cases per year, of whom approximately 21 000 die (PDVI, 2010). The global yearly cost of case management attains US$1.8 billion (Suaya et al. 2009) and control measures cost between US$0.2 and US$36 per inhabitant (Suaya et al. 2007; Baly et al. 2009). Participation of the community in the control of the Aedes aegypti mosquito, the main vector of the virus, is claimed to be essential for sustainable dengue prevention (Parks & Lloyd 2004; Toledo et al. 2008), but a systematic review found only few reports of its effectiveness on vector densities and even fewer of its impact on transmission (Heintze et al. 2007).

We previously assessed in intervention trials and through operational research in two Cuban provincial capitals, Santiago and Guantánamo, the effectiveness (Toledo et al. 2006), cost-effectiveness (Baly et al. 2007), sustainability (Toledo et al. 2007) and transferability (Vanlerberghe et al. 2009) of community-based environmental management strategies intertwined with a routine A. aegypti control programme. Despite convincing results in terms of vector infestation levels – reductions up to 75% – we could not demonstrate impact on transmission because dengue is not endemic in Cuba.

Methods and results
During the protracted, low-intensity dengue outbreak that struck Santiago de Cuba between April 2006 and March 2007 (PAHO, 2006), we conducted an observational...
study. We used the setting of a quasi-experimental community trial that we had run between January 2001 and December 2002 in the Consejo Popular Mariana Grajales, an administrative subdivision of Santiago, with around 8000 inhabitants (Toledo et al. 2006). From 2003 onwards – after withdrawal of the external support – we had monitored the sustainability of the trial’s effects on community activities, behavioural changes and Stegomyia indices (Toledo et al. 2007).

In the trial, neighbourhood task forces were created in 29 randomly selected intervention house blocks (covered by six family medicine practices), and routine vector control activities alone were conducted in the remaining 30 neighbouring control blocks. The main components of the community-based strategy in the intervention blocks (described in detail in Toledo et al. 2006) were (i) establishment and training of a formal task force, the community working groups (CWG), in each area of responsibility of the family medicine practices, (ii) securing intersectoral coordination between the CWG and the existing local government and health structures and (iii) creation of formal links with the routine vector control programme.

The CWG were composed of formal and informal leaders, volunteers, family medicine practice personnel (who live in the community) and vector control staff. They identified the main health needs and subsequently elaborated and implemented action plans related to A. aegypti control. These included, among others, elimination of environmental risk in public areas, transformation of garbage belts into vegetable gardens, repairing of broken water pipes and manufacturing of lids for water containers. Routine vector control comprises source reduction through periodic inspection of houses, adding larvicides to water storage containers, selective perifocal spraying, health education and enforcement of mosquito control legislation through fines.

Community working groups were still in place and continued organizing community-based A. aegypti control activities in the (former) intervention blocks at the time of the 2006–2007 dengue outbreak. Routine vector control activities were intensified throughout the whole of Santiago after detection of the first cases in April 2006. In the present study, we evaluated vector infestation levels and incidence and distribution of clinical dengue cases in the original intervention and control blocks. Information was extracted from statistical reports of the entomological and epidemiological routine surveillance system. A clinical case of dengue was defined as a suspect case (fever and one of the following signs or symptoms: myalgia, arthralgia, retro-orbital pain, headache or rash) confirmed by immunoglobulin M-capture enzyme-linked immunosorbent assay (IgM test). We computed Breteau Indices (number of positive containers for A. aegypti per 100 houses) and dengue attack rates per epidemiological week, using as numerator the number of cases and as denominator the average 2006 population in the intervention and control clusters (3887 and 4073 inhabitants, respectively).

After the onset of the outbreak in the municipality of Santiago, the first sporadic cases in intervention and control blocks were detected in week 6 and week 3, respectively (Figure 1). In the intervention blocks, cases

![Figure 1](image-url)
only started multiplying in week 22, and the epidemic lasted for 5 weeks. In the control blocks, the number of cases started to increase earlier (in week 15), and the epidemic lasted for 16 weeks. The attack rate of dengue fever over the epidemic period was 8.5 and 38.1 per 1000 inhabitants, respectively. This corresponds to a relative risk of 4.5 (95% CI 3.1–6.5) and a preventable fraction in the control blocks of 78% (if the participatory strategy had been implemented there). Furthermore, the distribution of the number of cases per block (Table 1) was significantly different ($\chi^2$ for trend = 19.9; $P < 0.01$): there were more unaffected intervention blocks, and control blocks had on average substantially more cases per affected block. The average Breteau Index was 2.0 and 5.2, respectively ($P < 0.01$).

This study offers no ‘level 1’ evidence of the effect of community involvement in A. aegypti control on dengue transmission, but it provides a convincing bundle of converging evidence. We have previously demonstrated in a cluster randomized trial (Vanlerbergh et al. 2009) the effectiveness of the tested intervention for reducing A. aegypti infestation levels and documented its sustainability in a controlled intervention (Toledo et al. 2007). We show in the present observational study that when a dengue outbreak eventually occurs, the transmission is lower in the community-based intervention house blocks where pilot activities were maintained, than in the control blocks.

The previously randomly selected blocks have very similar environmental and socioeconomic characteristics (Toledo et al. 2006), and climatic factors can obviously not confound our results. Post-intervention ‘contamination’ of the control blocks cannot be excluded, but this would lead to underestimating the impact. The functioning and coverage of the Cuban Dengue surveillance system, which actively screens the population for fever during outbreaks, the health service strategy to hospitalize all suspect cases and the confirmation of cases in an international reference laboratory (Guzman et al. 2006), permits the assumption that the observed differences are not attributable to differential case registration. We did not ascertain subclinical infection by a seroprevalence survey, but there is no evidence of different past-exposure immunity between blocks and no other apparent reason to suspect different clinical/subclinical ratios.

Very few studies of community-based environmental management for A. aegypti control used incidence of clinical dengue cases as outcome measure. Kay and Vu (Kay & Nam 2005) described the involvement of the community in the implementation of a biological control method (copepods) in Vietnam, which resulted in 77% reduction in dengue incidence. Kittayapong et al. (2008) reported from Thailand the local suppression of dengue transmission with an integrated participatory strategy encompassing the use of copepods, Bacillus thuringiensis, lethal larvitraps and environmental management. Our results corroborate these findings and complement, with evidence of impact on dengue transmission, our earlier referenced studies in Cuba that demonstrated the effectiveness of community participation in A. aegypti control.

**Conclusion**

This study, together with the mentioned studies in Vietnam and Thailand, demonstrates that the involvement of the community can not only reduce vector infestation levels but also have an impact on dengue transmission – regardless of differences in the routine dengue control programmes and in dengue epidemiology. How to ensure long-term sustainability, successful scaling up and appropriate adaptation of the strategies used to specific national contexts remain a challenge for public health authorities and a topic for urgently needed further research.

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Corresponding Author Maria E. Toledo, Instituto de Medicina Tropical ‘Pedro Kouri’, Havana, Cuba. E-mail: mariaeugenia@ipk.sld.cu.