fibrinogen levels, and reduced platelet aggregation.[16] The question is if the balance between beneficial and harmful effects is affected by drinking pattern.

Heavy alcohol drinking is positively associated with many problems such as liver diseases, cancers, and road crashes, and overall mortality is higher among individuals with a high alcohol intake compared with light consumers. Also, the beneficial effect of alcohol is probably confined to middle aged or older people.[17] Therefore the inverse association between alcohol intake and coronary heart disease should be viewed in this context when giving public health advice.

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Effective control of dengue vectors with curtains and water container covers treated with insecticide in Mexico and Venezuela: cluster randomised trials

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Abstract

Objectives To measure the impact on the dengue vector population (*Aedes aegypti*) and disease transmission of window curtains and water container covers treated with insecticide.

Design Cluster randomised controlled trial based on entomological surveys and, for Trujillo only, serological survey. In addition, each site had a non-randomised external control.

Setting 18 urban sectors in Veracruz (Mexico) and 18 in Trujillo (Venezuela).

Participants 4743 inhabitants (1095 houses) in Veracruz and 5306 inhabitants (1122 houses) in Trujillo.

Intervention Sectors were paired according to entomological indices, and one sector in each pair was randomly allocated to receive treatment. In Veracruz, the intervention comprised curtains treated with lambdacyhalothrin and water treatment with pyriproxyfen chips (an insect growth regulator). In Trujillo, the intervention comprised curtains treated with longlasting deltamethrin (PermaNet) plus water jar covers of the same material. Follow-up surveys were conducted at intervals, with the final survey after 12 months in Veracruz and nine months in Trujillo.

Main outcome measures Reduction in entomological indices, specifically the Breteau and house indices.

Results In both study sites, indices at the end of the trial were significantly lower than those at baseline, though with no significant differences between control and intervention arms. The mean Breteau index dropped from 60% (intervention clusters) and 113% (control) to 7% (intervention) and 12% (control) in Veracruz and from 38% to 11% (intervention) and from 34% to 17% (control) in Trujillo. The pupae per person and container indices showed similar patterns. In contrast, in nearby communities not in the trial the entomological indices followed the rainfall pattern. The intervention reduced mosquito populations in

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neighbouring control clusters (spill-over effect); and houses closer to treated houses were less likely to have infestations than those further away. This created a community effect whereby mosquito numbers were reduced throughout the study site. The observed effects were probably associated with the use of materials treated with insecticide at both sites because in Veracruz, people did not accept and use the pyriproxyfen chips.
Conclusion Window curtains and domestic water container covers treated with insecticide can reduce densities of dengue vectors to low levels and potentially affect dengue transmission.

Introduction

Dengue is the most common and fastest spreading human arboviral disease worldwide. Control of the vector mosquito, *Aedes aegypti*, is the only effective preventive measure. Reduction of mosquito breeding in household water vessels through larvicides, predatory crustaceans, or elimination of discarded containers, and control of adult mosquitoes by spraying with insecticide, require a continuous effort by the community, can be difficult to sustain and expensive.

Bed nets treated with insecticide can prevent transmission of nocturnally transmitted vector-borne diseases including malaria, Chagas' disease, leishmaniasis, and lymphatic filariasis. Such materials have not been used to control the vectors of dengue. We tested the efficacy of window curtains treated with insecticide and treated water containers in reducing dengue entomological and serological indices.

Methods

Study areas

In Mexico (October 2002 to November 2003) we conducted our study in Agua Dulce, Veracruz. There is one rainy season (June-October), the mean annual rainfall is 1160 mm, and the mean temperature 21°C. All households were eligible, and 4743 people in 1095 households participated in the study. No activities to control mosquitoes had been carried out in the four months before the study.

In Venezuela (January to November 2003) we carried out the study in Trujillo. There are two rainy seasons (March/April and November), the mean annual rainfall is 750 mm, and temperatures range from 16-37°C. We selected one large suburb of the city in which limited interventions to control mosquitoes had been carried out in previous months. All households were eligible, and 1122 households with 5306 inhabitants were included.

Study design

We conducted a cluster randomised trial at each site with a sample size of nine pairs of clusters. Each study site was divided into 18 sectors of similar size (means of 61 and 62 houses per sector in Veracruz and Trujillo, respectively). Sectors were separated by streets of about 6 m wide.

Baseline surveys—We carried out baseline surveys in all study sectors. Primary end points were the Breteau index (number of containers with immature stages per 100 houses) and the house index (number of houses containing immature stages per 100 houses); secondary end points were the pupae per person index, the container index, and IgM serology (see bmj.com).

Pairing of sectors—We paired sectors taking into account baseline values of Breteau index, house index, and housing conditions. One sector from each pair was randomly allocated to the intervention or control arm.

Interventions—In Veracruz, 524 houses (95% of all intervention houses) received polyester net curtains treated by hand with insecticide hung loosely at the windows (mean 2.8 curtains per household). Initially, chips of the larval growth inhibitor pyriproxyfen in a cloth infusion bag were suspended in all water containers of 10 litres or more. Control sectors received no interventions. Acceptance rates of pyriproxyfen were low: only 29% (881/3022) of containers still had bags after two weeks, and only 17% (372/2172) at five months. We found around two thirds of these remaining bags incorrectly placed in wells. Since this intervention did not contribute significantly to the trial outcome it is not discussed further. In Trujillo, 492 houses (87% of intervention houses) received PermaNet curtains and water jar covers. Control sectors received no interventions. Curtains were used as in Veracruz and covers provided for all household water drums (typically 150-200 l), where most vector breeding occurs. In both study sites the curtains were impregnated again after five to six months because of expected decrease of insecticide activity with direct exposure to sunshine. Numbers of participating households fell by 22% in Veracruz and 33% in Trujillo because of absence of heads of household and because people were tired of letting researchers enter their premises.

Entomological monitoring—We repeated baseline measurements after two to four weeks and at four months. Final data were collected after 12 months in Veracruz and nine months in Trujillo. For external control data we used entomological indices collected as part of routine surveillance by vector control programmes in neighbouring areas. Rainfall data were obtained for the city of Trujillo and the state of Veracruz.

Serological survey—A house-to-house serosurvey was carried out in Trujillo when the intervention began (March 2003; 698 houses) and eight months later (November 2003; 640 houses). Houses were selected randomly from both control and intervention clusters. A blood sample was taken by venous puncture from one individual aged >15 years (usually the housewife). Samples were analysed for anti-dengue IgM by enzyme linked immunosorbent assay.

Attitudes of participants—We gauged attitudes towards the interventions through informal interviews at the beginning and end of the study, and a satisfaction survey of heads of household in intervention clusters at the end.

Statistical analysis

For each of the four entomological indices, we used paired t tests to compare intervention and control areas and baseline and final follow-up data, each sector contributing one data point according to intention to treat. We assessed variation of baseline values between sectors for the Breteau index. The coefficient of variation, k, was 0.71 in Veracruz and 0.10 in Trujillo. The value for the house index, treated as a proportion, was 0.22 in Veracruz. In Trujillo, the method yielded a negative value for k^2, which we interpret as a low degree of clustering. Clustering of the house index was also assessed at various spatial scales and spill-over effect between clusters assessed. See bmj.com for details.

Results

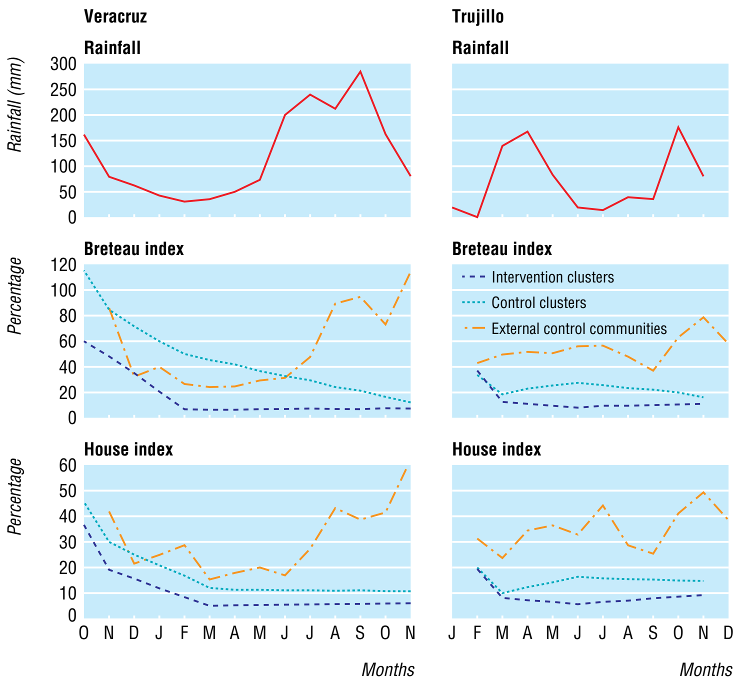
Window curtains treated with insecticide

At baseline, the mean Breteau and house indices in Veracruz were 86% and 41% respectively, mean pupae per person index was 2.7 and the ovitrap index (% of houses with one or two ovitraps with *Aedes* eggs)[1] was 31%. After the intervention began the mean Breteau and house indices immediately fell in the intervention households (from 60% to 46% and from 36% to 19%, respectively, at two weeks after the intervention) and in the control households (Breteau index from 113% to 87% and house index from 45% to 30%) (figure). In the next months the fall continued to low levels in both intervention and control sectors. At 12 months, the mean Breteau and house indices were lower in the intervention arm but not significantly so (P = 0.27 and 0.16) (see bmj.com). Both indices, however, showed a clear decline after baseline in both intervention and control arms. The Breteau index fell from 60% to 7% (P < 0.001) in the intervention group and from 113% to 12% in the control group (P = 0.02), with the house index falling from 36% to 6% (P < 0.001) and from 45% to 10% (P = 0.001), respectively. Similar reductions in intervention group were also seen in the pupae per person index (from 3.4 at baseline to 0.36 after 12 months), the container index (from 7% to 1%), and the ovitrap index (from 28% to 11%), with comparable but less dramatic declines occurring in control groups (pupae per person index from 2.0 to 0.35; container index from 14% to 2%; ovitrap index from 33% to 16%).

Window curtains and water container covers treated with insecticide

At baseline in Trujillo, large household water drums (150-200 l) comprised 57.8% of all positive containers and 24% (245/1008) of these drums were positive for vector larvae or pupae, or both. Shortly after the intervention began there were significant reductions in intervention sectors in the Breteau index (from 38% to 12%), the house index (from 19% to 7%), and the pupae per person index (from 3.0 to 0.3 (figure). After nine months, there was no significant difference between control and intervention arms (P = 0.18 for both Breteau and house indices). Reductions from baseline, however, were significant or borderline. Interestingly, the ovitrap index showed a different pattern, increasing from 25% to 39% after four months and then slowly falling to the original level after 10 months (25%). Moreover, the container index barely changed, from 5% to 4% after four months and 4% after 10 months. Presumably, without access to preferred breeding sites, vectors were diverted to other sites.

Prevalence of IgM measured at baseline was 16% (64/398) and 21% (62/300) in intervention and control clusters, respectively. After eight months, this had dropped to 8% (27/330) in the intervention clusters but had not changed significantly in the control groups (18%, 56/310). The paired test for the mean difference at eight months gave a P value of 0.06.



Breteau and house indices in intervention and control clusters and in external control communities at baseline and end of studies in Veracruz (Mexico) and Trujillo (Venezuela), with monthly local rainfall data

Evidence for a community-wide effect

These findings suggest a spill-over effect occurred, whereby the intervention affected neighbouring control clusters, reducing their vector populations. This is consistent with the findings that in external control sites remote from the interventions, seasonal changes in the vector population corresponded to rainfall and were markedly different to those within the study sectors (figure). Spatial analysis indicated that houses located closer to treated houses were less likely to have infestations than those further away (see bmj.com).

Acceptance of interventions

Two weeks after intervention 95% (524/553) and 87% (492/568) of houses in Veracruz and Trujillo, respectively, had at least one treated curtain; the proportions were 88% (403/456) in Veracruz and 96.0% (386/402) in Trujillo at five months. In formal and informal interviews household members remarked positively on the variety of dead insects found daily below the treated curtains.

In Trujillo, of the 283 water jar covers originally distributed, 68% (193/283) were still in use after five months. Although these covers were generally well accepted, they were not always used correctly, were not durable and tore easily with constant use. In both sites there were no reported adverse events attributed to the interventions.

Discussion

Use of curtains and jar covers made with material treated with insecticide can reduce the number

What is already known on this topic

Vector control aimed at reducing the density of the dengue vector, *Aedes aegypti*, to low levels is the only presently available measure for preventing dengue transmission

Larviciding, insecticide spraying or elimination of domestic water containers through community involvement are labour intensive and often difficult to sustain

What this study adds

Use of window curtains treated with insecticide alone or in combination with treated jar covers can substantially reduce the dengue vector population and potentially reduce disease transmission

of dengue vectors and potentially reduce disease transmission.

Limitations and strengths
The proximity of intervention and control clusters led to a spill-over effect, shown by the spatial analysis that masked the magnitude of the effect of the intervention on the mosquito population and on disease transmission. However, the study also showed a marked and prolonged reduction in the dengue vector population that continued during the wet season. By contrast, untreated dengue vector populations in the external control communities had increased in the months after the intervention. Thus the treated materials in the intervention households had both a household and, as shown by the spill-over, a community-wide effect on dengue vectors. Similar results have been shown for malaria.[2 3]

We also carried out a before and after assessment to analyse the reduction occurring within the intervention and control arms. This showed reductions in the Breteau and house indices and also in the pupae per person index.[4] The lack of such trends in the external control areas suggests that the interventions did, in fact, cause the observed reductions. The Trujillo serological study further suggests that the intervention significantly affected dengue transmission. Larger trials of insecticide treated material alone and in combination with other interventions are now starting in Asia and Latin America.

Carmen Elena Castillo organised the serosurvey and Milagros Oviedo assisted with entomological monitoring in Trujillo; Oscar Aldana, IMSS-OPORTUNIDADES, Mexico, collected the external control data in Veracruz; and Manuel Zorrilla organised the field work in Veracruz. Field support was provided by staff from IMSS-OPORTUNIDADES (Mexico) and Universidad de los Andes (Venezuela). Support by various authorities—J Cabral, C Escandon (IMSS-OPORTUNIDADES) and J Mendez Galvan (Secretarìa de Salud) in Mexico, and J Scorza and E Rojas (Universidad de los Andes) in Venezuela—was crucial.

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My worst day

The day was always going to be bad. It was the middle of winter, we had too many patients, and, as the second on-call house officer, I was holding the crash bleep. Predictably, when the first crash call of the day came I was at the opposite end of the hospital. I left my senior house officer and hurried down to the radiology department as I had been directed. By the time I arrived, resuscitation was already well in progress. With horror, I realised it was one of my team's patients. After 10 minutes, the attempt at resuscitation was abandoned, and the dead patient was taken back to the ward.

I went ahead of the patient to talk to her family, who had been taken to the relatives' room. Even if I do say so myself, I made a pretty good job of breaking the bad news to them. The only problem was that, as I was on the crash team, I hadn't been able to leave my bleep outside the room, and the second crash call of the day occurred while I was with the family. I made my apologies and left the room. At least I didn't have far to run, as the crash was on the ward I was already on. I hurried into the side room to realise that it was to the "dead" patient for whom we'd recently stopped resuscitation. Although unconscious, she now had a pulse and a decent blood pressure. The attending nurse had put out the call, not knowing what else to do. The rest of the crash team arrived, including the senior house officer who had declared the patient dead earlier.

After much discussion with senior colleagues, it was agreed that intensive care was not appropriate. I was too upset by the whole scenario to talk again to the relatives and tell them that a mistake had been made, so one of the senior house officers talked to them instead. The patient was given supportive care on the ward and died a few hours later.

When it comes to life or death situations, it never pays to be too hasty in jumping to conclusions.

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We welcome articles up to 600 words on topics such as *A memorable patient, A paper that changed my practice, My most unfortunate mistake,* or any other piece conveying instruction, pathos, or humour. Please submit the article on http://submit.bmj.com Permission is needed from the patient or a relative if an identifiable patient is referred to. We also welcome contributions for "Endpieces," consisting of quotations of up to 80 words (but most are considerably shorter) from any source, ancient or modern, which have appealed to the reader.