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REVIEW

What do community-based dengue control programmes achieve? A systematic review of published evaluations

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Summary Owing to increased epidemic activity and difficulties in controlling the insect vector, dengue has become a major public health problem in many parts of the tropics. The objective of this review is to analyse evidence regarding the achievements of community-based dengue control programmes. Medline, EMBASE, WHOLIS and the Cochrane Database of Systematic Reviews were searched (all to March 2005) to identify potentially relevant articles using keywords such as '*Aedes*', 'dengue', 'breeding habits', 'housing' and 'community intervention'. According to the evaluation criteria recommended by the Cochrane Effective Practice and Organisation of Care Review Group, only studies that met the inclusion criteria of randomised controlled trials (RCT), controlled clinical trials (CCT), controlled before and after trials (CBA) or interrupted time series (ITS) were included. Eleven of 1091 studies met the inclusion criteria. Of these, two were RCTs, six were CBAs and three were ITS. The selected studies varied widely with respect to target groups, intervention procedures and outcome measurements. Six studies combined community participation programmes with dengue control tools. Methodological weaknesses were found in all studies: only two papers reported confidence intervals (95% CI); five studies reported *P*-values; two studies recognised the importance of water container productivity as a measure for vector density; in no study was cluster randomisation attempted; and in no study were costs and sustainability assessed. Evidence that community-based dengue control programmes alone and in combination with other control activities can enhance the effectiveness of dengue control programmes is weak.

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1. Introduction

The WHO has classified dengue, including dengue fever (DF), dengue haemorrhagic fever (DHF) and dengue shock syndrome (DSS), as an infectious disease with a dramatic negative influence on health, the environment and the economy (Gibbons and Vaughn, 2002). Dengue is of particular importance in Asia, the Americas and the Western Pacific where it has become increasingly endemic with epidemic outbreaks (Guzman et al., 2002, 2004; Kroeger et al., 2004). One-half of the world's population lives in countries endemic for dengue, underscoring the urgency to find solutions to control this vector-borne disease.

Human behaviour, influenced by social, cultural, economic and political factors (Heggenhougen et al., 2003), can increase or decrease the risk of dengue infection depending on the relationship with the insect vector. All the time that no vaccine is available, the spread of dengue can only be curtailed by controlling vector populations (*Aedes aegypti* and others) and by protecting individuals. *Aedes* larvae are the main target for vector control efforts; they can be reduced by using biological agents, including larvivorous fish (e.g. *Poecilia reticulate*, *Gambusia affinis*) and copepods (e.g. *Mesocyclops*) (Kay et al., 2002), larvicides (e.g. *Bacillus thuringiensis* subsp. *israelensis*, methoprene, permethrin, temephos) and by eliminating water containers. Environmental management is generally considered an important component of dengue prevention and control.

In the last few decades, efforts to promote community-oriented activities for dengue control have increased. These have included multicomponent interventions to reduce larval, and ultimately adult, vector populations through chemical, biological and physical interventions as well as behavioural change at the community level.

The objective of this paper is to provide a systematic and comprehensive overview of the available evidence for the effectiveness of community-based interventions in reducing vector populations for dengue control.

2. Methods

A literature search was carried out in April 2005 of Medline, EMBASE, the Cochrane Database of Systematic Reviews (CDSR; published in The Cochrane Library) and the WHO's library database (WHOLIS). All databases were searched from inception to March 2005. The term 'dengue' and DF/DHF/DSS was combined with the terms 'intervention', 'health behaviour', 'health promotion', 'human activities' and 'community'. Search terms included MeSH and free-text terms. Additionally, the bibliographies of all identified publications were checked to identify further relevant studies. Searches were restricted to papers written in English, Spanish and German.

Publications that presented original data from trials evaluating the effect of community-based dengue control interventions were included. A community-based dengue control intervention was defined as any intervention in which at least one component targeted the community (e.g. educational meetings, involvement of local leaders) and whose aim was to reduce the incidence of dengue disease or infestation of the community with *Aedes* mosquitoes (as measured by any entomological index). A second inclusion criterion was that the study design must be of acceptable quality with regard to assessment of the outcome of an intervention. Following the recommendations of the Cochrane Effective Practice and Organisation of Care Review Group (EPOC), which is concerned with evaluating interventions in community healthcare settings, only studies that provided some kind of comparison between the intervention setting and the non-intervention setting were included (Ramsay, 2005). Acceptable study designs were randomised controlled trials (RCT), controlled clinical trials (CCT), controlled before and after trials (CBA) and interrupted time series (ITS). The characteristics of these trials are shown in Table 1. However, unlike the EPOC criteria, three data points before and three data points after the intervention were not required to consider a study an ITS. Any other kind of study design was excluded. Publications reporting interventions with no community participation (i.e. top-down vector control programmes) as well as conference papers, clinical observations and non-systematic overview articles were excluded.

The quality of the publications was assessed independently by two of the authors (C.H. and M.V.G.); differences in quality assessment were resolved by consensus with the third author. The quality of the studies included was scored as 0—8 (with 8 indicating the highest quality) on the basis of study design and reporting quality. In assessing study design, both the type of control group (RCT = 3, CCT = 2, CBA = 1, ITS = 0) and the length of the observation period (>12 months = 1, <12 months = 0) were taken into account. In assessing reporting quality, description of effect estimates (reported = 1, not reported = 0), confidence intervals or deviation measures (reported = 1, not reported = 0) and *P*-values (reported = 1, not reported = 0) as well as discussion of potential confounders (discussed = 1, not discussed = 0) were taken into account.

Information transferred from the reviewed articles into evidence tables included geographical setting, features of the interventions (i.e. what was done, how it was delivered, who was targeted, where it was delivered and by whom), level of participants (communities, households, individuals), major outcome measures (dengue incidence, entomological indices), length of observation period and results.

3. Results

The electronic literature search identified a total of 1091 papers potentially eligible for inclusion in the review. A total of 11 papers were identified that met the inclusion criteria (see Figure 1 for selection process) and were assessed in detail. All reviewed articles were published between 1992 and 2005 and describe control strategies that eliminate common habitats of *Aedes* mosquitoes. The studies varied with respect to the target group, the intervention procedure and the kind of controls involved. Five studies were carried out in the Americas and six in Asia. The length of the observation period after the intervention was 6 months (Avila Montes et al., 2004; Espinoza-Gomez et al., 2002), 6—12 months (Fernandez et al., 1998; Kay et al., 2002; Leontsini et al., 1993; Raju, 2003; Sanchez et al., 2005; Swaddiwudhipong et al., 1992) and >12 months (Lardeux et al., 2002; Nam

Table 1 Cochrane Effective Practice and Organisation of Care Review Group (EPOC) checklist

Randomised controlled trial (RCT)	Trial in which the participants (or other units) were: (a) assigned prospectively to one or two (or more) alternative forms of health care using a quasi-random allocation method (e.g. alternation, date of birth, patient identifier); (b) possibly assigned prospectively to one or two (or more) alternative forms of health care using a process of random or quasi-random allocation.
Controlled clinical trial (CCT)	Trial in which the participants (or other units) were: (a) assigned prospectively to one or two (or more) alternative forms of health care using a quasi-random allocation method (e.g. alternation, date of birth, patient identifier); (b) possibly assigned prospectively to one or two (or more) alternative forms of health care using a process of random or quasi-random allocation.
Controlled before and after study (CBA)	Trial with involvement of intervention and control groups other than by random process, and inclusion of baseline period of assessment of main outcomes. There are two minimum criteria for inclusion of CBAs. (a) Contemporaneous data collection: score calculated for pre- and post-intervention periods for study and control sites are the same. (b) Appropriate choice of control site (studies using second site as controls): score calculated if study and control sites are comparable with respect to dominant reimbursement system, level of care, setting of care and academic status.
Interrupted time series (ITS)	Trial with changes in trend attributable to the intervention. There are two minimum criteria for inclusion of ITS designs in EPOC reviews. (a) Clearly defined point in time when the intervention occurred. Score not calculated if reported that intervention did not occur at a clearly defined point in time. (b) At least three data points before and three after the intervention. Score not calculated if less than three data points recorded before and three data points recorded after the intervention.

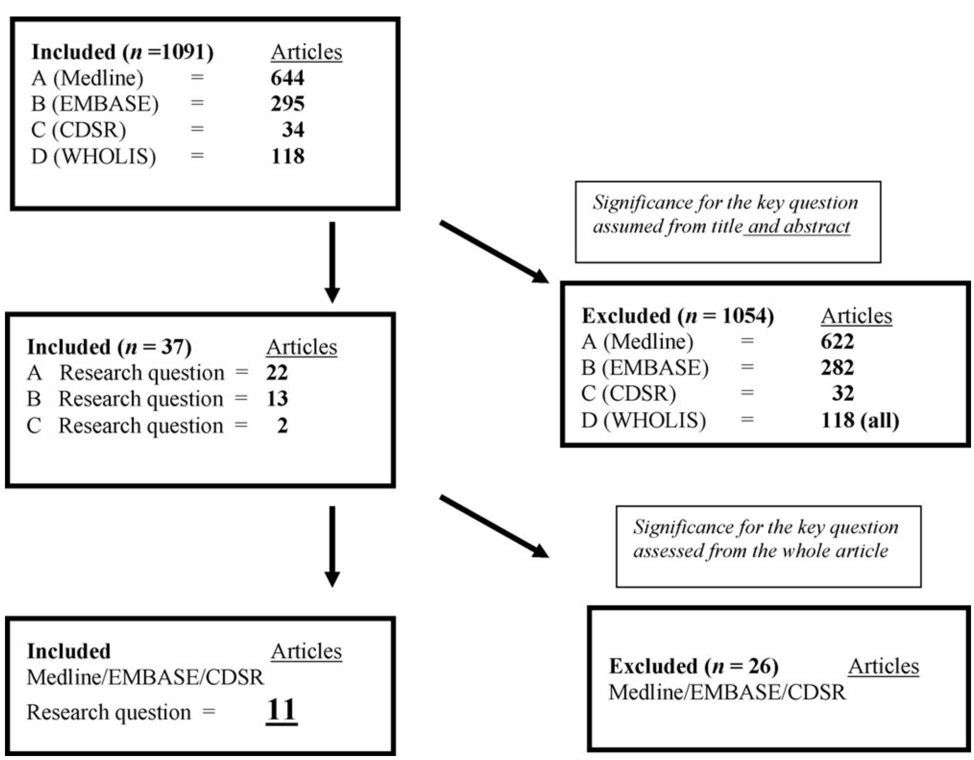

Figure 1 Selection process for dengue-related articles. CDSR: Cochrane Database of Systematic Reviews.

Table 2 Design and quality of included studies (calculation of the score in the text)

Reference	Methodological quality		Reporting quality				Quality score
	Design	Length of observation	Effect estimate in HI, BI or CI	95% CI	*P*-value	Description of confounding	
Exclusively community-based dengue control							
Sanchez et al. (2005)	CBA	12 months	Yes (HI)	Yes	No	Yes	5
Avila Montes et al. (2004)	CBA	6 months	Yes (HI, BI)	No	Yes	No	3
Raju (2003)	ITS	9 months	Yes (HI, BI, CI)	No	No	No	1
Fernandez et al. (1998)	CBA	12 months	Yes (CI)	No	Yes	No	4
Leontsini et al. (1993)	RCT	12 months	Yes (BI)	No	Yes	Yes	7
Community-based dengue control in combination with chemical larvicides							
Espinoza-Gomez et al. (2002)	RCT	6 months	Yes (HI, BI, CI)	Yes	Yes	Yes	7
Swaddiwudhipong et al. (1992)	ITS	12 months	Yes (HI, BI, CI)	No	No	No	2
Community-based dengue control in combination with fish and chemicals larvicides							
Lardeux et al. (2002)	CBA	>12 months	Yes (HI, CI)	No	Yes	Yes	5
Wang et al. (2000)	ITS	>12 months	Yes (BI)	No	No	No	2
Community-based dengue control in combination with *Mesocyclops*							
Nam et al. (2005)	CBA	>12 months	No	No	No	Yes	3
Kay et al. (2002)	CBA	12 months	Yes (BI)	No	No	No	3

HI: House Index; CI: Container Index; BI: Breteau Index.

et al., 2005; Wang et al., 2000). The number of targeted persons ranged from 500 (Lardeux et al., 2002) to 100 000 (Fernandez et al., 1998). Two studies (Leontsini et al., 1993; Wang et al., 2000) reported the number of villages but not the population size.

3.1. Study design

Table 2 describes the design and reporting quality of the 11 studies. Two of the studies were RCTs, six were CBAs and three were ITS, according to the EPOC checklist (Ramsay, 2005). Overall, the quality of studies was fair to good (Table 2). Most studies compared intervention communities with control ('untreated') communities. Only one paper reported stratified randomised allocation of communities to the intervention or control groups (Leontsini et al., 1993). The three ITS studies (Raju, 2003; Swaddiwudhipong et al., 1992; Wang et al., 2000) can be considered of poor quality; only one had a data collection point before the intervention. In general, the presentation of results can also be considered unsatisfactory. Only two papers (Espinoza-Gomez et al., 2002; Sanchez et al., 2005) reported confidence intervals (95% CI) and only five studies reported *P*-values (Avila Montes et al., 2004; Espinoza-Gomez et al., 2002; Fernandez et al., 1998; Lardeux et al., 2002; Leontsini et al., 1993). Assessment of potential confounders (e.g. climate factors in the study region, level of exposure to educational materials, adherence of the participants) was also lacking in most of the papers and, when present, was limited to qualitative discussion, with no quantitative data for statistical analysis.

3.2. Intervention strategies

Table 3 summarises the characteristics of the interventions, the main target groups and the results. Almost one-half of the studies (5/11; 45%) were exclusively community-based dengue interventions. Two studies (18%) involved the community in using chemical larvicides, two studies (18%) involved the community in introducing copepods (*Mesocyclops*) and two studies (18%) involved larvivorous fish combined with application of chemical larvicides. In seven studies, local knowledge, attitudes and practices (KAP) were surveyed before the intervention began (Avila Montes et al., 2004; Espinoza-Gomez et al., 2002; Fernandez et al., 1998; Lardeux et al., 2002; Leontsini et al., 1993; Sanchez et al., 2005; Swaddiwudhipong et al., 1992).

Seven studies used educational materials (distribution of printed recommendations), nine studies used educational meetings (workshops or traineeships) and eight studies used educational outreach visits (where trained persons met with providers in their local settings to impart information with the intention of changing behaviour). Six studies described the involvement of local opinion leaders, five studies mentioned the involvement of national institutions and five studies used the mass media (radio, television, newspaper, leaflets, posters) in the implementation of dengue control programmes (Table 3). The target groups of single intervention components (i.e. educational meetings or outreach visits) were mainly schoolchildren, teachers and women; however, not all target groups were specified in the different studies.

3.3. Assessment tools

Different methods were used to evaluate the outcome of the intervention strategies. In all studies, classical entomological indices such as the House Index (HI), the Container Index (CI) and the Breteau Index (BI) were used to estimate the efficacy of the intervention, except for the study by Nam et al. (2005) where more advanced larval stages (LIII, IV)

Table 3 Characteristics and selected results

Reference	Location of study	Intervention			Control		Main results[a]
		Unit of allocation	Target groups	Intervention	Unit of allocation	Specifications of the control	
Exclusively community-based dengue control							
Sanchez et al. (2005)	Cuba, Havana	Municipality with 27 030 inhabitants	Elderly and children	Use of educational meetings Involvement of local opinion leaders Involvement of national institutions Use of education by mass media Pre-arrangement with a KAP survey	Neighbouring municipality with 14 219 inhabitants	Non-specific public sanitation programme	Intervention areas $HI_0 = 3.71\%$ $HI_t = 0.61\%$ Control areas $HI_0 = 1.31\%$ $HI_t = 1.65\%$ Favours intervention
Avila Montes et al. (2004)	Honduras, Tegucigalpa	Municipality with 9071 inhabitants	Schoolchildren	Use of educational materials Use of educational meetings Involvement of national institutions Use of education by mass media Pre-arrangement with a KAP survey	Neighbouring municipality, not specified	Not specified	Intervention areas BI_0 = n.r. $BI_t = 30.5\%$ HI_0 = n.r. $HI_t = 23.4\%$ Control areas BI_0 = n.r. $BI_t = 26.5\%$ HI_0 = n.r. $HI_t = 38.1\%$ Differences among groups not significant ($P = 0.08$)
Raju (2003)	Fiji Islands, Lautoka	Peri-urban area with 17 000 habitants	Not specified	Educational outreach visits Involvement of national institutions	n.a.	n.a.	$BI_0 = 29\%$ $BI_t = 0\%$ $HI_0 = 21\%$ $HI_t = 0\%$ $CI_0 = 17$ $CI_t = 0\%$
Fernandez et al. (1998)	Honduras, El Progreso	11 villages belonging to 'El Progreso' (100 000 habitants)	Women (person in charge of cleaning the washbasins/drum)	Use of educational materials Use of educational meetings Educational outreach visits Use of education by mass media Pre-arrangement with a KAP survey	8 villages belonging to 'El Progreso' (100 000 habitants)	Not specified	Intervention areas $CI_0 = 26.6\%$ $CI_t = 19.7\%$ Control areas $CI_0 = 31.4\%$ $CI_t = 24.2\%$ Differences among groups not significant
Leontsini et al. (1993)	Honduras, El Progreso	Randomly selected 4 villages in 'El Progreso' (100 000 habitants)	Health committees (mostly women)	Use of educational materials Use of educational meetings Educational outreach visits Involvement of local opinion leaders Use of education by mass media Pre-arrangement with a KAP survey	Randomly selected 4 villages in 'El Progreso' (100 000 habitants)	Not specified	Intervention areas $BI_0 = 32\%$ $BI_t = 34\%$ Control areas $BI_0 = 25\%$ $BI_t = 46\%$ Differences among groups significant ($P < 0.01$), favouring the intervention group

Table 3 (*Continued*)

Reference	Location of study	Intervention			Control		Main results[a]
		Unit of allocation	Target groups	Intervention	Unit of allocation	Specifications of the control	
Community-based dengue control in combination with chemical larvicides							
Espinoza-Gomez et al. (2002)	Mexico, Colima	Randomly selected houses (education alone, $n = 47$; education + insecticides, $n = 49$; insecticide alone, $n = 46$; no intervention, $n = 45$ houses; from total of 7000 houses in Colima)	Household inhabitants (mostly housewives)	Use of educational materials Use of educational meetings Educational outreach visits Involvement of national institutions Pre-arrangement with a KAP survey	Randomly selected houses ($n = 91$) (total of 7000 houses in Colima)	No intervention ($n = 45$) Insecticides alone ($n = 46$)	Overall (all groups) $BI_0 = 97.3\%$ $BI_t = 70\%$ $HI_0 = 54\%$ $HI_t = 41.17\%$ $CI_0 = 35\%$ $CI_t = 31.2\%$ Education only $C+/H_0 = 1.255$ $C+/H_t = 0.382$ Education + insecticide $C+/H_0 = 0.530$ $C+/H_t = 0.326$ Insecticide alone $C+/H_0 = 1.108$ $C+/H_t = 1.022$ Control (no intervention at all) $C+/H_0 = 1.022$ $C+/H_t = 1.155$ Differences among groups significant ($P < 0.005$), favouring the educational intervention
Swaddiwudhipong et al. (1992)	Thailand, Mae Sot District	6341 houses in a municipality of 20 283 habitants	Healthcare personnel, government officers, schoolchildren, teachers and community organisations	Use of educational meetings Involvement of local opinion leaders Use of education by mass media Pre-arrangement with a KAP survey	n.a.	n.a.	$BI_0 = 79.0\%$ $BI_t = 34.4\%$ $HI_0 = 39.1\%$ $HI_t = 10.0\%$ $CI_0 = 240.9$ $CI_t = 61.3$ $I_0 = 892/100\,000$ $I_t = 685/100\,000$
Community-based dengue control in combination with fish and chemical larvicides							
Lardeux et al. (2002)	French Polynesia, Rangiroa	500 habitants (150 premises)	Not specified	Use of educational materials Use of educational meetings Educational outreach visits Pre-arrangement with a KAP survey	900 habitants (250 premises)	Not specified	Intervention areas $CI_0 = 100\%$ $CI_t = 15.8\%$ $HI_0 = 58.8\%$ $HI_t = 0\%$ Control areas $CI_0 = 85\%$ $CI_t = 83.3\%$ $HI_0 = 80\%$ $HI_t = 60\%$ Differences among groups significant ($P < 0.05$), favours intervention
Wang et al. (2000)	Taiwan, Ping-Tung	8 villages in Thailand (not specified)	Teachers	Educational outreach visits Involvement of local opinion leaders	n.a.	Not specified	$BI_0 = 54.0\%$ $BI_t = 1.2\%$

Community-based dengue control in combination with *Mesocyclops*							
Nam et al. (2005)	Vietnam, Northern Provinces	Three communes with 5913 houses (population of 27 169)	Schoolchildren, teachers	Use of educational materials Use of educational meetings Educational outreach visits Involvement of local opinion leaders	One commune with 2165 houses (population of 10 419)	Not specified	Intervention areas I_0 = 1541/100 000 I_t = 0/100 000 Control areas I_0 = n.r. I_t = n.r.
Kay et al. (2002)	Vietnam, Haiphong	6 communes with 11 675 houses (population of 49 647)	Schoolchildren, teachers, Women's Union	Use of educational materials Use of educational meetings Involvement of local opinion leaders Involvement of national institutions	4 communes with 8792 houses (population of 37 665)	Not specified	Intervention areas BI_0 = 0 to 57% BI_t = 0 to 3% Control areas BI_0 = 23 to 53% BI_t = 30 to 35% Favours intervention

HI_0: House Index at baseline; HI_t: House Index at endpoint; BI_0: Breteau Index at baseline; BI_t: Breteau Index at endpoint; CI_0: Container Index at baseline; CI_t: Container Index at endpoint; I_0: dengue incidence at baseline; I_t: dengue incidence at endpoint; C+/H: positive containers per house; n.r.: not reported; n.a.: not applicable; KAP, knowledge, attitudes and practices.
[a] Related to the major indicator.

were used as an estimate of adult vector density (equivalent to conducting a pupal survey) (Gubler and Clark, 1996; Lloyd et al., 1994). In Thailand (Raju, 2003), the number of serologically/virologically-confirmed dengue cases was used as an outcome measure, and in Vietnam (Nam et al., 2005) the dengue incidence rates were reported. Only one study (Espinoza-Gomez et al., 2002) described the outcome of the different control activities used in each intervention arm separately (education alone; insecticides alone; education and insecticides; control group).

3.4. Efficacy of community-based dengue control

According to the 11 studies reviewed, use of community-based interventions in dengue vector control programmes appears to be promising in terms of reducing larval indices. All the studies showed a reduction of larval indices or, more importantly, a reduction in seroconversion or incidence of dengue disease (Table 3).

However, the extent to which these reductions can be attributed to the interventions varies widely across the studies, since some designs leave much room for confounding or bias, particularly those that followed an ITS design. Nevertheless, the two studies with the highest quality score (both from Central America and using a RCT design) showed that the interventions had a statistically significant effect on the entomological index (Espinoza-Gomez et al., 2002; Leontsini et al., 1993).

Among the studies exclusively assessing community-based dengue control, one RCT (quality score 7) (Leontsini et al., 1993) and one CBA (quality score 5) (Sanchez et al., 2005) showed statistically significant differences between the intervention and control areas. In two further CBA studies, the differences were not statistically significant.

Two studies assessed the effectiveness of community-based dengue control combined with the use of chemical larvicides (Espinoza-Gomez et al., 2002; Swaddiwudhipong et al., 1992). In both, one of which had a high quality score (7), there was significant reduction in the entomological index. Another two studies assessed community use of larvivorous fish and chemical larvicides (Lardeux et al., 2002; Wang et al., 2000); in the intervention groups of both studies there were reductions in the entomological index. However, during the observation period (1990—1996) in one of the studies, a natural decrease observed in the larval indices was not taken into account, thus the association of reduced larval indices with the intervention in this case is unclear.

In two CBA studies in Vietnam, community-based dengue vector control with *Mesocyclops* was implemented. In one of the studies (Kay et al., 2002), reduction of *Aedes* infestation was demonstrated in the environment of a remarkably large population of 49 647 people. The study by Nam et al. (2005) showed a striking reduction of dengue incidence in the three intervention communities compared with non-intervention communities in the same district; the entomological impact was measured through reduction of late larval stages (LIII/LIV) (see above).

In both of the high-quality evaluations, a statistically significant effect of the intervention was shown; a KAP assessment performed at baseline and at the intervention included distribution of educational materials, organisation of educational meetings and educational outreach visits.

4. Discussion

4.1. Selection of studies

The intervention-based selection criteria for the studies to be included meant that classical and more recent papers on the organisation and challenges of community-based vector interventions (e.g. Gubler and Clark, 1994; Lloyd et al., 1992, 1994; Winch et al., 2002) were not reviewed in this paper. They describe the complexity but also the benefits of working with communities and set the scene for social interventions in addition to or together with technical vector control interventions.

4.2. Comparability of studies

The 11 studies on community-based dengue interventions in combination with other control efforts used a study design that can be considered appropriate according to the EPOC statement. Nevertheless, the studies differed in several aspects, including intervention strategy, type of behaviour addressed, main target group, length and intensity of the intervention and outcome measurements. None of the studies involved a cluster randomised trial, which is appropriate for analysis of area interventions (Ukoumunne et al., 1999).

This makes interpretation of the results difficult. In no study was the sustainability of community-based dengue control strategies or the cost of the interventions assessed, so it remains questionable whether community efforts can be sustained long enough to have a lasting effect on dengue vectors.

It is generally unclear which element of the intervention was mainly responsible for the effect of the control programme. The one study that reported relative effectiveness of single components indicated that the educational element of the intervention was responsible for much of the observed effect (Espinoza-Gomez et al., 2002). Comparative analysis is difficult because different behavioural changes (cleaning containers, waste disposal, use of biological methods, or a combination of these) and different actors (schoolchildren, teachers, women, unspecified groups) were targeted. These individual variables might have different impacts on the effectiveness of dengue vector control programmes as well as different cost implications. However, it is reasonable to suggest that 'tailoring interventions' (e.g. using different channels of community participation simultaneously) is important for community-based dengue control.

In most studies, information about local knowledge and beliefs was collected and a consultative approach with the beneficiaries of dengue control programmes was attempted. It is likely that better understanding of the living conditions, use of water and daily life experiences in communities will make it easier to design interventions with community involvement. However, the studies did not indicate how information from the KAP surveys was used to design the subsequent control strategy.

4.3. Outcome measurement

Various indicators were proposed to measure the impact of *Aedes* infestations. Most of the studies involved traditional mosquito larval indices (HI, BI or CI) to measure changes in larval populations, regardless of container productivity (Focks, 2003; Focks and Alexander, 2006; Nathan et al., 2006). These indices provide only a measure of larval populations, which is not associated with adult vector density or disease transmission; furthermore, confounding factors that are beyond the reach of communities, such as communal water supply, garbage collection services or population density, were not sufficiently discussed in most of the papers. Thus, changes in larval habitats can only be used as an indirect indicator of changes in human behaviour.

In addition, most of the papers did not describe exactly the type of water containers or where vector infestation was present, except for the study by Nam et al. (2005). The results of the interventions are therefore difficult to interpret.

All 11 studies aimed at eliminating larval *Aedes* habitats from the local domestic environment, but none provided specific information regarding whether community members were involved in the planning, implementation or future direction of the dengue control programme. In most of the studies, community members simply participated and did what they were told. Poor monitoring of behavioural change and lack of a coherent model for maintaining community involvement were identified as major threats for the sustainability of COMBI (communication for behavioural impact) projects (Elder, 2005).

5. Conclusions

Our findings suggest that although community-based control strategies in addition to or together with biological and chemical vector control tools are able to reduce classical *Aedes* larval indices, it is unknown whether this reduces dengue transmission. Only the studies conducted in Thailand and Vietnam provide information regarding reduction of vector density (estimated by LIII and IV larvae) and disease transmission (estimated by reported/re-confirmed dengue cases or seroconversion). These studies also suggested that co-ordinated involvement of local health services, trained vector control personnel, civil authorities and the community could contribute to converting information into practice and encourage communities to take over prevention and control measures. This underlines the importance of intersectoral co-operation.

The results of this review are in line with social science theory, which suggests that multifaceted interventions are more effective than single interventions because a larger variety of barriers for change can be addressed (Parks and Lloyd, 2004).

Future research should aim at distinguishing which specific components of the intervention strategy (e.g. larvicides, biological control agents), in combination with community participation and/or other partnership, have the greatest impact on dengue control and are cost effective. Particular attention must be paid to the issue of sustainability of dengue vector control strategies, which should be maintained and monitored through a variety of stakeholders at an affordable cost.

Conflicts of interest statement
The authors have no conflicts of interest concerning the work reported in this paper.

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