A systematic review of community-based interventions for emerging zoonotic infectious diseases in Southeast Asia

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Executive Summary

Background

Southeast Asia has been at the epicentre of epidemics of emerging and re-emerging zoonotic diseases. Detection and control of infectious diseases in resource constrained settings is more likely to be influenced by community-based surveillance activities and behavioural change interventions than centralised resource intensive activities. Over the last decade there have been increased efforts to promote community-based infectious disease control. Given the high burden of disease and limited resources in these settings, there is a need to identify effective and efficient community-based strategies to combat zoonotic diseases.

Objectives

This review aimed to: (i) determine the effectiveness of community-based surveillance interventions at monitoring and identifying outbreaks of emerging zoonotic infectious diseases, (ii) establish the effectiveness of non-pharmaceutical community-based interventions at reducing the incidence of emerging zoonotic infectious diseases, and (iii) identify contextual factors that impact on the effectiveness of surveillance and control interventions.

Inclusion criteria

Participants: Studies that evaluated interventions that were non-pharmaceutical, non-vaccine, and community-based. The review was restricted to the ten member countries of the Association of Southeast Asian Nations: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam.

Types of intervention(s): Surveillance or prevention and control interventions targeting rabies, Nipah virus , dengue fever, severe acute respiratory virus (SARS) or avian influenza.

Types of outcomes: Primary outcomes measuring the incidence of infection or disease, and secondary outcomes that provided information on the functioning, uptake or sustainability of the surveillance and/or control program.

Types of studies: Quantitative studies providing primary evidence or systematic reviews of quantitative evidence.

Search strategy

The following databases from 1980 to 2011 were accessed: PubMed, CINAHL, ProQuest, EBSCOhost, Web of Science, Science Direct, the Cochrane Library, the WHO library database (WHOLIS), British Development Library, LILACS, World Bank (East Asia) and the Asian Development Bank.

Methodological quality

Quantitative papers selected for retrieval were critically appraised by two independent reviewers using standardised instruments from the Joanna Briggs Institute Meta Analysis of Statistics Assessment and Review Instrument. Disagreements were resolved through discussion.

Data extraction

Quantitative data were extracted using a specially developed data extraction tool that captured the interventions, populations, study methods, program theory, disease outcomes and process indicators. Qualitative data constituting contextual information or narrative evidence provided by

the authors on why interventions have been (in)effective and any comment on sustainability were also extracted.

Data synthesis
Data was synthesised in a narrative summary with the aid of tables and figures, using the frameworks for evaluating infectious disease surveillance systems and behavioural interventions to guide categorisation. Meta-analysis was used to statistically pool results where appropriate.

Results
57 studies were included in the review. The quality of the studies was generally poor to medium. Most studies reported intermediate or process outcomes rather than information on incidence of disease, and most studies had insufficient follow up periods. Evidence for the costs, feasibility and sustainability of these programs was also lacking.

The largest body of evidence was found for **dengue** fever surveillance and prevention and control interventions. Findings showed that a significant number of suspected cases of dengue haemorrhagic fever do not access healthcare, and there is considerable underreporting to the provincial health office. Vector control based around use of copepods, environmental cleanup and education campaigns is effective in reducing incidence of **dengue** and is sustainable in both rural and urban communities.

Surveillance interventions for **avian influenza** have been generally successful in identifying highly pathogenic avian influenza (HPAI) in backyard flocks, but have not been broadly applied. Prevention and control activities evaluated for **Nipah virus** and **SARS** were associated with outbreak control activities. These were effective but not suitable for use in ongoing control programs. Canine vaccination in conjunction with dog population control, movement restrictions and education has proved more acceptable than culling, but still fails to reach levels of coverage required to be effective in reducing rates of **Rabies**.

Several contextual factors, behavioural mechanisms and program characteristics were found that influence community engagement with, and ultimately the effectiveness and sustainability of, surveillance and control activities.

Conclusion
There have been large investments in several countries in South East Asia on training, educational and surveillance initiatives, but published evidence on the evaluation of many of these programs was not identified. Where evidence is available it contains a high risk of bias and our conclusions should be interpreted with caution. Given this, a range of different surveillance and control interventions have been shown to be effective at monitoring and controlling disease where high levels of coverage and community engagement and ownership are achieved. To achieve this, sensitivity to local context, perceptions about disease, and attitudes to surveillance and control activities is essential. Several key factors influencing community engagement with surveillance and control interventions were identified and these may have implications for future research and practice. Identification of the best models for particular settings will require evidence not only on effectiveness, but local acceptability, cost, cost-effectiveness and sustainability. Both future research and practice would benefit from strengthening of linkages between national veterinary and local animal health services, and human health.

Implications for practice

Good levels of community participation are achieved where community perception of the public health importance of the disease and the effectiveness of the intervention are high. Interventions are more effective if they have access to central coordination and support. Educational interventions on their own without provision of opportunities or support for behavioural change are not effective. Higher levels of effectiveness are achieved when the community is involved in all stages of the program. Linkages between veterinary and public health surveillance systems are essential in monitoring zoonotic disease as animals represent the main source of infection. Limited evidence was identified for programs based on the framework of 'One Health'. Some contextual information is available showing linkages need to be multi-level and be compatible with economic activity to be successful, however, no information was provided in the studies on how linkage of these systems is best achieved.

No detailed evidence for risk assessment in development of interventions, program planning tools or frameworks was identified. Where no situational analysis has been conducted, this limits the ability to draw conclusions about which interventional approach may be most appropriate for a given setting.

Implications for research

More research is required in this area given the current lack of rigorous evaluations. Future research is needed to provide evidence on the structure, functioning and outcomes of current local and national surveillance systems for emerging infectious diseases to assess sustainability. Novel low-cost methods of surveillance should be explored further. Evaluations of prevention and control programs need to be longitudinal, with longer follow-up times, and report data on the impact on disease outcomes, health knowledge and practices, acceptability, cost and sustainability of programs. Future evaluations of educational interventions should be conducted around models of behaviour change. Evaluations of successful interventions need replication across different countries and contexts to assess generalisability. Translational research is needed to understand how best to roll out successful programs as regional or national programs without compromising effectiveness.

Keywords: Community; intervention; surveillance; prevention and control; rabies; Nipah virus ; dengue; SARS; avian influenza; emerging infectious diseases; zoonoses; Southeast Asia

Abbreviations used in this review

AAHL	Australian Animal Health Laboratory
AI	Avian Influenza
AIDS	Acquired Immunodeficiency Syndrome
ASEAN	Association of Southeast Asian Nations
AusAID	Australian Agency for International Development
BI	Breteau index
Bti	Bacillus thurigensis
CDC	Centers for Disease Control and Prevention
CEDAC	Centre d'Etude et de Developement Agricole Cambodgien
CI	Container index
DF	Dengue fever
DfID	Department for International Development
DHF	Dengue haemorrhagic fever
DI	Density Index
DVS	Department of Veterinary Services, Malaysia
ELISA	Enzyme-linked immunosorbent assay
EMPRES	FAO Emergency Prevention System
EPOC	Cochrane Effective Practice and Organisation of Care Review Group
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GPS	Global positioning satellite
HI	House Index
HPAI	Highly pathogenic avian influenza
JBI	Joanna Briggs Institute
JBI-MAStARI	JBI-Meta-Analysis of Statistics Assessment and Review Instrument
KAP	Knowledge, attitudes and practices
Lao PDR	Lao People's Democratic Republic
LDCC	Local Disease Control Centres
LJA	Lao Journalists' Association
MOH	Ministry of Health
NaVRI	National Veterinary Research Institute, Cambodia

NGO	Non-government organisation
OFFLU	OIE/FAO network of expertise on avian influenza
OI	Ovitrap Index
OIE	International Office of Epizootics
OR	Odds ratio
PDSR	Participatory Disease Surveillance and Response
PEP	Post-exposure prophylaxis
PET	Post-exposure treatment
PHU	Public health unit
PPE	Personal protective equipment
PPI	Pupae per person index
PPV	Positive predictive value
RNAS (+)	Regional Network on Asian Schistosomiasis and Other Helminth Zoonoses
RR	Rate ratio
SARS	Severe acute respiratory syndrome
SE Asia	Southeast Asia
SEARO	South-east Asia Regional Office (of WHO)
SES	Socio-economic status
SNT	Serum neutralisation test
IT	Insecticide-treated
ULV	Ultra-low volume
USAID	United States Agency for International Development
VHV	Village health volunteer
VWU	Viet Nam Women's Union
WHO	World Health Organization
WHOLIS	WHO library database
WRPO	Western Regional Pacific Office (of WHO)

Background

The 2004 WHO/FAO/OIE joint consultation on emerging zoonotic diseases defined such diseases as, "a zoonosis that is newly recognized or newly evolved, or that has occurred previously but shows an increase in incidence or expansion in geographical, host or vector range".[1] Avian influenza, severe acute respiratory syndrome (SARS), Nipah virus, monkeypox, Hendra virus, and the lentiviruses that cause Acquired Immunodeficiency Sydrome (AIDS) are a few examples of the growing number of diseases that humans can contract from animals.

The Asia Pacific Region has, unfortunately, been at the epicentre of such epidemics. Over 30 new infectious agents have been detected in the last three decades, 75% of which were zoonotic.[2] A number of factors contribute to these circumstances. The absence of effective surveillance and control programs, prevailing socio-cultural practices and weak public health and veterinary services infrastructure exacerbates the vulnerability of these settings. Other factors including climate change, environmental degradation, encroachment of humans on areas where wildlife exists, cohabitation of humans and food animals within households, and the mixing of species in live animal markets play a role in increased disease transmission.

Influenza remains a global priority with the potential to cause large, global epidemics. Approximately 10% to 15% of people worldwide contract influenza annually, with attack rates as high as 50% during major epidemics.[3] In 2003 the SARS epidemic affected around 8000 people and killed 780. In 2006 a new avian H5N1, and in 2009, a new H1N1 'swine' influenza pandemic threat, caused widespread anxiety.[4]

In addition to mortality and morbidity, zoonotic diseases have and are predicted to cause huge economic losses. The economic cost of the major outbreaks of new epidemic zoonotic diseases over the past decade, including SARS and H5N1 influenza, has been estimated to be $200 billion.[4]

To prevent and control zoonotic infections in Southeast Asia (SE Asia), a multi-sectoral and multi-disciplinary approach, involving many levels of the health and non-health sector, is needed, which places a strong emphasis on both the early detection and early control of infectious disease outbreaks.

Surveillance activities

Early detection of disease outbreaks requires effective disease surveillance systems. Systems in developing countries face many operational challenges, including a lack of accurate and timely information exchange between local, provincial, national and regional levels, and inadequate human resource and laboratory capacity for speedy diagnosis. The WHO's Asia Pacific Strategy for Emerging Diseases 2010 highlights the need for community involvement in surveillance.[2] Zoonotic disease detection and control also depends on effective veterinary surveillance and the ability to contain outbreaks amongst animal populations, systems that are often poorly developed or non-existent in developing countries.

Jones *et al.*[5] suggest that local targeted surveillance of at-risk people may be the best way to prevent large-scale emergence. Brownstein *et al.*[6] in their discussion of web surveillance suggest that the use of news media and other non-traditional sources of surveillance data such as web-accessible discussion sites and disease reporting networks could facilitate early outbreak detection and increase public awareness of disease outbreaks prior to their formal recognition. May *et al.*[7] review the evidence for syndromic surveillance systems in developing countries (systems utilising existing clinical data prior to a diagnosis) and find that this may be a feasible and effective approach to infectious disease surveillance in developing countries.

Evaluating surveillance activities

The effectiveness of surveillance systems in responding generally to emerging infectious diseases has not been reviewed systematically. Reviews aimed at particular contexts (for example, prevention of bioterrorism[8] and public health surveillance for trachoma[2]) have been undertaken, however, neither review was able to state whether surveillance systems are achieving the ultimate goal of detecting outbreaks early and providing an accurate picture of infection rates in the area covered by the surveillance program.[2]

Most evaluations of surveillance programs have been qualitative, and focused on evaluating the practical structure and operation of the system, rather than the impact on infectious disease transmission.[9-11] Many researchers have used the Centers for Disease Control and Prevention (CDC) guideline which recommends how a surveillance system can be assessed to verify if it meets its objectives.[12] This provides a framework for evaluating how well a system is functioning and determining reasons why it may or may not be functioning to detect and respond to infectious disease outbreaks and/or support ongoing control activities to tackle endemic diseases.

The CDC guideline recommends that reports of surveillance systems include the following:

- descriptions of the public health importance of the health event under surveillance; the system under evaluation; the direct costs needed to operate the system; the usefulness of the system;
- evaluations of the system's simplicity, stability (its ability to withstand external changes), flexibility (that is, "the system's ability to change as surveillance needs change"), acceptability ("as reflected by the willingness of participants and stakeholders to contribute to the data collection, analysis and use"), sensitivity to detect outbreaks, positive predictive value of system alarms for true outbreaks, representativeness of the population covered by the system, and timeliness of detection.

Prevention and control activities

Control of emerging infectious disease requires an effective response to surveillance data. Single measures such as the use of vaccines or antiviral drugs may be unavailable, unaffordable or not in sufficient quantity. The control of these infectious diseases in resource constrained settings is more likely to be influenced by community-based and behavioural change interventions as well as by strengthening of national and international commitment to their control.[13] Over the last decade there have been increased efforts to promote community-based infectious disease control.[2]

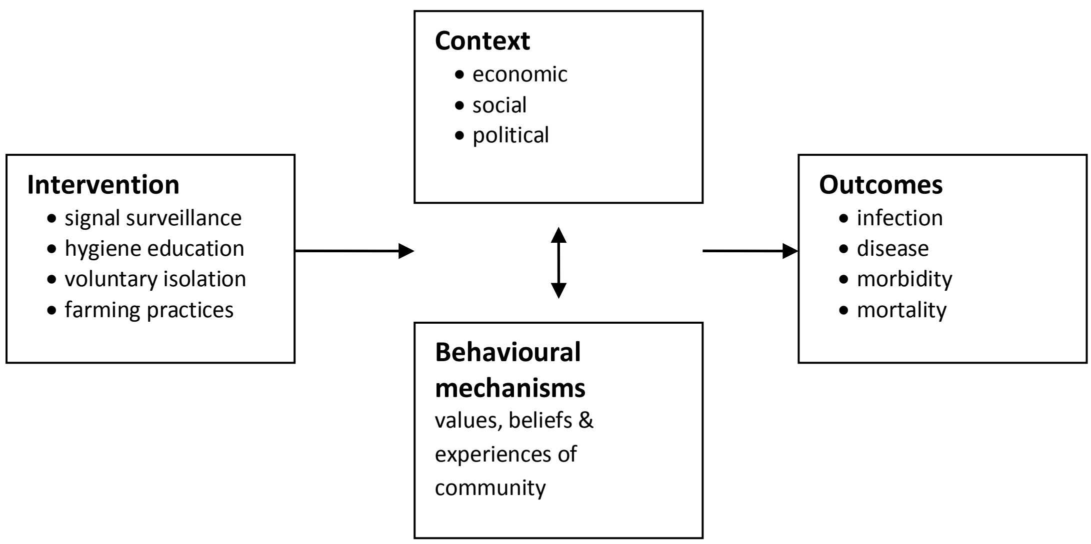
For vector-borne infections, such as dengue, attention has been focused on interventions to reduce larval, and ultimately adult, vector populations. Programs have attempted to achieve this via a range of chemical, biological and physical interventions to reduce vector populations, as well as trying to initiate behavioural change at the community level to prevent contact with the mosquito vectors.[14] Heintze *et al.* have previously reviewed the evidence for community-based dengue control programs.[15] This systematic review completed in 2005 found at that time that the evidence for these activities was weak and inconclusive and suggested a number of priorities for future research in this area. However, the review has not since been updated.

Community-based interventions to control the spread of respiratory viruses, such as influenza, have focused on hygiene and respiratory etiquette to prevent human-to-human transmission. Many of these interventions have only been evaluated in a developed country context. Aledort *et al.*[16] and Jefferson *et al.*[13] undertook systematic reviews of physical interventions to interrupt or reduce the spread of respiratory viruses. Both reviews found handwashing was effective whilst there was no evidence to support school/workplace closure. However, these findings are from a predominantly North American context and may not be generalisable to countries with limited access to safe water and sanitation.

Evaluating control activities

To understand whether community-based control activities will be effective and why requires us to look at the behavioural mechanisms through which these interventions work and the context in which they are based. Behavioural mechanisms operate through the experiences, beliefs and values of groups and individuals. These mechanisms are therefore dependent in part on the context in which they are used. This framework was used in a recent synthetic review of water and sanitation projects.[17] The framework is shown in Figure 1.

Figure 1: Framework for evaluating the impact of context and behavioural mechanisms on intervention outcomes



Review objective/questions

The objective of this review is to identify the effectiveness of surveillance systems and community-based interventions in identifying and responding to emerging and re-emerging zoonotic infections in SE Asia.

It aims to provide a critical review of published evidence that evaluated the effectiveness of community-based surveillance and prevention and control interventions for emerging zoonotic infectious diseases. In addressing the three research questions outlined below we will summarise evidence for not only the effectiveness of community surveillance and prevention and control interventions in SE Asia in identifying and responding to these infectious diseases, but also explore the contextual factors that influenced their success.

More specifically the review questions were:

1. What is the effectiveness of community-based surveillance interventions designed to identify emerging zoonotic infectious diseases?
2. What is the effectiveness of non-pharmaceutical community-based interventions designed to prevent transmission of emerging zoonotic infectious diseases?
3. How do factors related to the emergence and management of emerging zoonotic infectious diseases impact the effectiveness of interventions designed to identify and respond to them?

Inclusion criteria

Types of participants

This review considered studies that evaluated interventions that are non-pharmaceutical, non-vaccine, and community-based. Community-based is defined as implemented outside a healthcare institution with at least one component of the intervention targeted directly at the community (e.g. educational meetings, involvement of local leaders). Interventions with no community participation (i.e. top-down vector control programs) were excluded as they were outside the scope of this project.

The review was limited to the ten member countries of the Association of Southeast Asian Nations (ASEAN)[18]: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam, and the following diseases of interest developed from the list of emerging and re-emerging zoonotic infections published on the CDC website[19] as commonly occurring in Southeast Asia:

- rabies
- Nipah virus
- dengue
- SARS, and
- avian influenza

Types of intervention(s)/phenomena of interest

Interventions of interest included, but were not limited to:

Surveillance Interventions: syndromic surveillance programs, communications programs, training/education of health workers and community workers to detect and/or prevent disease, local level surveillance & response teams, web surveillance. Following the One Health[20] concept of a synergistic approach to health we will also include animal/livestock surveillance systems where they are specifically evaluated with respect to their impact on human health and disease outcomes.

Control Interventions (subcategorised into the following):

Health promotion interventions: self-reporting of suspected infections, promotion of voluntary self isolation, advocating use/provision of personal protective equipment, e.g. masks, public/community education on hygiene and respiratory etiquette, safe slaughter and preparation of animals and animal products (in particular poultry),

Physical interventions: contact tracing, isolation, quarantine, social distancing, barriers, school/workplace closure, movement restriction,

Environmental interventions: environmental cleaning, waste disposal, coverage or removal of water containers, vector control, larval control including larvivorous fish and copepods, destruction of potentially infected animals and animal products

Types of outcomes

Primary outcomes: A range of different outcomes used in the studies were examined. For the purposes of this review, they can be broadly categorised into primary and secondary outcomes. Primary outcomes aim to measure the incidence of infection or disease in the community. We considered studies that reported any type of quantitative infection/disease/outbreak outcome data or morbidity and mortality rates attributable to the infectious disease. This includes the following types of primary outcome measures: rates of infection, numbers of cases of infection reported and confirmed mortality rates attributable to the infectious disease, rates of hospitalisation attributable to the infectious disease, number of outbreaks, time/size of epidemic peak, duration of outbreak/epidemic.

Secondary outcomes: To help contextualise our findings and address review question three, we also extracted any information on other indicators relating the functioning of the surveillance and/or control program. These indicators can be used as intermediate outcomes to predict how the intervention might impact on infection or disease. For example, an intervention program may not show a reduction in disease but may result in an improved capacity for detection and containment of outbreaks or high levels of vector control. We categorised indicators based around the WHO framework for the monitoring and evaluation of surveillance and response systems for communicable disease[21] and categorise these as secondary outcomes:

- *Process indicators*: Activities such as training sessions delivered, guidelines developed or number of sites monitored,

- *Output indicators*: The results of the activities conducted e.g. proportion of surveillance centres providing timely reporting, number of households with containers covered, proportion of the community attending education session,
- *Outcome indicators*: The extent to which the surveillance and response objectives are being achieved, including the quality of the surveillance systems and the appropriateness of any outbreak response e.g. proportion of outbreaks where appropriate control response initiated, incidence-reporting-response times, numbers of larvae/vectors, improvements in knowledge relating to hygiene education campaigns.

Types of studies

Following the recommendations of the Cochrane Effective Practice and Organisation of Care Review Group (EPOC),[22] which is concerned with evaluating interventions in community healthcare settings, only studies that provide evidence that draws a comparison between an intervention setting and a non-intervention setting were included. A second inclusion criterion was that the study must report results as quantitative infection/disease/outbreak data (as described under types of outcomes). We aimed to include studies reporting original primary data or systematic reviews of this type of evidence (i.e. not theoretical model based studies).

Acceptable study designs included: systematic reviews/meta-analyses, randomised controlled trials, controlled clinical trials, controlled before and after trials, interrupted time series (we require only one time point before and after the intervention). We also accepted mixed-method studies that included one of the above, and systematic review and economic evaluations that were based on one of the above. Conference papers, clinical observations, program reports with only one time point and non-systematic overview articles were excluded.

The quantitative component of the review extracts data from included studies on all disease outcomes and process indicators measured. This information is used to address review questions 1 and 2.

The textual component of the review considers the textual information included in the introduction, methods and discussion of all papers included in this systematic review. This is used to supplement the quantitative information on process indicators and address review question 3.

Search strategy

Studies published in any language with an abstract available in the English language were considered for inclusion in this review. Studies were assessed for inclusion based on title and abstract only; with studies only translated if they met inclusion criteria. Studies published between 1980 and 2011 were considered for inclusion in this review, with a start date of 1980 was chosen as surveillance programs in most SE Asian countries commenced in the early 1990s. By including data from 1980, we hoped to capture any information on community-based surveillance and intervention programs that may have contributed to the development of formal surveillance programs.

The databases searched included: PubMed, CINAHL, ProQuest, EBSCOhost, Web of Science, Science Direct, the Cochrane Library of systematic reviews, the WHO library database (WHOLIS), British Development Library, LILACS, World Bank (East Asia) and the Asian Development Bank. Further details on the search strategy are given in Appendix I.

Methods of the review

Assessment of methodological quality

Quantitative papers selected for retrieval were critically appraised by two independent reviewers prior to inclusion in the review using standardised instruments from the Joanna Briggs Institute Meta Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) (Appendix II). Any disagreements arising between the reviewers were resolved through discussion, or in consultation with a third reviewer.

Data collection

Quantitative data was extracted from papers included in the review using a data extraction tool specifically developed for this review that is shown in Appendix III. The tool was drafted during protocol development and piloted on a subset of studies across the five diseases. Based on this, a number of modifications were made to the tool to facilitate comparison across the diverse study types included in the review. The final tool still captured key details about the interventions evaluated and the methods and outcomes used in the evaluations, but to make extraction of contextual information easier for reviewers, the prescriptive categories used in the tool presented in the protocol were removed and replaced with three broad categories: contextual factors, behavioural mechanisms and program structure and delivery. These modifications allowed reviewers to capture the diverse range of factors reported in the studies and aided with categorisation of studies for the narrative analysis of findings.

Data was extracted on details about the interventions, populations, and study methods, program context and other outcomes of significance to the review question and specific review objectives. This included both disease outcomes and process indicators as described above to enable us to look at both the effectiveness and function of the programs.

To enable us to comment better on why programs have been (un)successful, we collected both quantitative data (i.e. process indicators) and qualitative data constituting narrative evidence or speculation by the authors on why interventions have been effective or not and any comment on sustainability. Textual data was extracted from the papers included in the quantitative review to capture the following specific details about the context and mechanisms of the program relevant to the review question and specific objectives:

- Features of the study setting, i.e. the geographical setting, the social, cultural and political context, the season,
- Features of the interventions i.e. what was done, how it was delivered, who was targeted, where it was delivered and by whom, funding organisation, technical and financial program details and any behavioural mechanisms targeted by the intervention,
- Level of participants i.e. communities, households, individuals, details on age and gender.

Data synthesis

Data extracted on the effectiveness of interventions and regarding the factors that aided or impeded effectiveness was synthesised in a narrative summary with the aid of tables and figures. We used the frameworks for evaluating infectious disease surveillance systems and behavioural interventions outlined in the background section to guide categorisation in our synthesis of this evidence where the evidence allowed us to, for surveillance activities we grouped abstracted information according to the CDC criterion for evaluating surveillance activities and for control programs we used a behavioural change framework to look at mechanisms and context for change.

Meta-analysis

Comparable study findings from individual studies were combined statistically in a meta-analysis. This approach allowed us to increase the power of the analysis, improve the precision of our estimates of an intervention and assess whether an intervention was similar in similar situations. The relative homogeneity in results across the different types of intervention supported this decision. Upon review of the data from the included studies, we elected not to use the Frequentist meta-analysis buiilt into the JBI-MAStARI statistical software (as originally outlined in the review protocol). We decided against this standard approach, which calculates odds ratios and 95% confidence intervals using the Mantel-Haenszel test as the default meta-analytical method for dichotomous data, in favour of a Bayesian approach that calculated odds or rate ratios with 95% credible intervals, for several reasons.

The Bayesian meta-analysis adjusts for multiple individual or repeated results from the same study (for example, results from two or more villages or from the same village at two or more time points) by using a random study effect, rather than combining the results across villages (for example, summing the total incidences and samples across all control villages and across all intervention villages). This accounts for instances where combining villages might be problematic (e.g., villages in high and low risk areas) and also adjusts for the fact that multiple within-study results are likely to be correlated and should not be entered as independent studies in a meta-analysis, nor should they be combined to give a study average, as this ignores the potentially valuable between-result heterogeneity (eg. villages in high and low and high risk areas). Standard meta-analysis software cannot model repeated results from the same study and is therefore likely to give a less accurate estimate. The Bayesian meta-analysis also easily copes with zero cells, for example, no positive results from a control village, which was not uncommon in studies of small sample sizes. Information about the underlying statistical assumptions and full set of equations and priors for the meta-analysis of binomial data has been included in the full meta-analysis report in Appendix VII, as well as the raw numbers used to generate the odds and rate ratios presented in the results section.

There were two types of dependent data in our analysis:
1. Counts of the number of successes and failures, for example, the number of containers that tested positive for mosquitoes and the total number of containers tested. These were modelled using a binomial distribution. The meta-analysis of count data weights all results by study size. Results were expressed as odds ratios.

2. Failure rates, for example the number of containers that tested positive for mosquitoes per 100 sampled. These data were modelled using a Poisson distribution. This data often did not provide information on the denominator used to calculate the rate so studies were unable to weighted by study size in the meta-analysis. Results were expressed as rate ratios.

The meta-analysis was easily fitted in R using the R2WinBUGS software version 1.4.3[23] and a Bayesian model with a random intercept for each study. We plotted the means and 95% credible intervals for the odds or rate ratios using the 'forestplot' function in the 'rmeta' library of the R software.[24] We generated plots at both the study and result level to visually show both the between-study and between-result variability. Odds ratios or rate ratios under one meant the intervention was effective; odds or rate ratios over one meant the intervention was not effective.

Uncertainty in estimates is expressed as a 95% credible interval, a standard approach in Bayesian statistical analyses, which has an interpretation similar to a 95% confidence interval (as would be calculated in the standard Frequentist meta-analysis orginally outlined in the protocol). A credible interval contains a 95% probability of containing the true estimate, in comparison to 95% confidence intervals, whose correct interpretation relies on imagining repeating the study multiple times, calculating multiple confidence intervals, and then counting the number of times the true estimate is contained in the intervals. Credible intervals therefore have a far simpler interpretation.

Due to the small numbers of studies reporting common outcomes, we were unable to carry out the planned sub-group analyses (which were by intervention type, urban/rural context and country). Instead, we pooled results across intervention types for meta-analysis, and a “leave one study out” sensitivity analysis was used to show the influence of each study on the summary odds or rate ratio when there were more than two studies. The relative homogeneity in results supported this decision.

Definitions

The following definitions were used to classify outcome measures in the meta-analysis:

- Household index (HI) is the proportion of households positive for Aedes aegypti larvae.
- Container index (CI) is the proportion of containers positive for Aedes aegypti larvae.
- Breteau index (BI) is the number of containers positive for Aedes aegypti larvae per 100 households.
- Larval population number (LPN) is the number of Aedes aegypti larvae counted in the survey.
- Larval density index (LDI) is the average number of larvae per house.
- Mosquito bite rate (MBR) is the average number of mosquito bites per person per hour.
- Rate of dengue haemorrhagic fever (R_{DHF}) is the number of cases of dengue haemorrhagic fever per 100,000 population

Review results

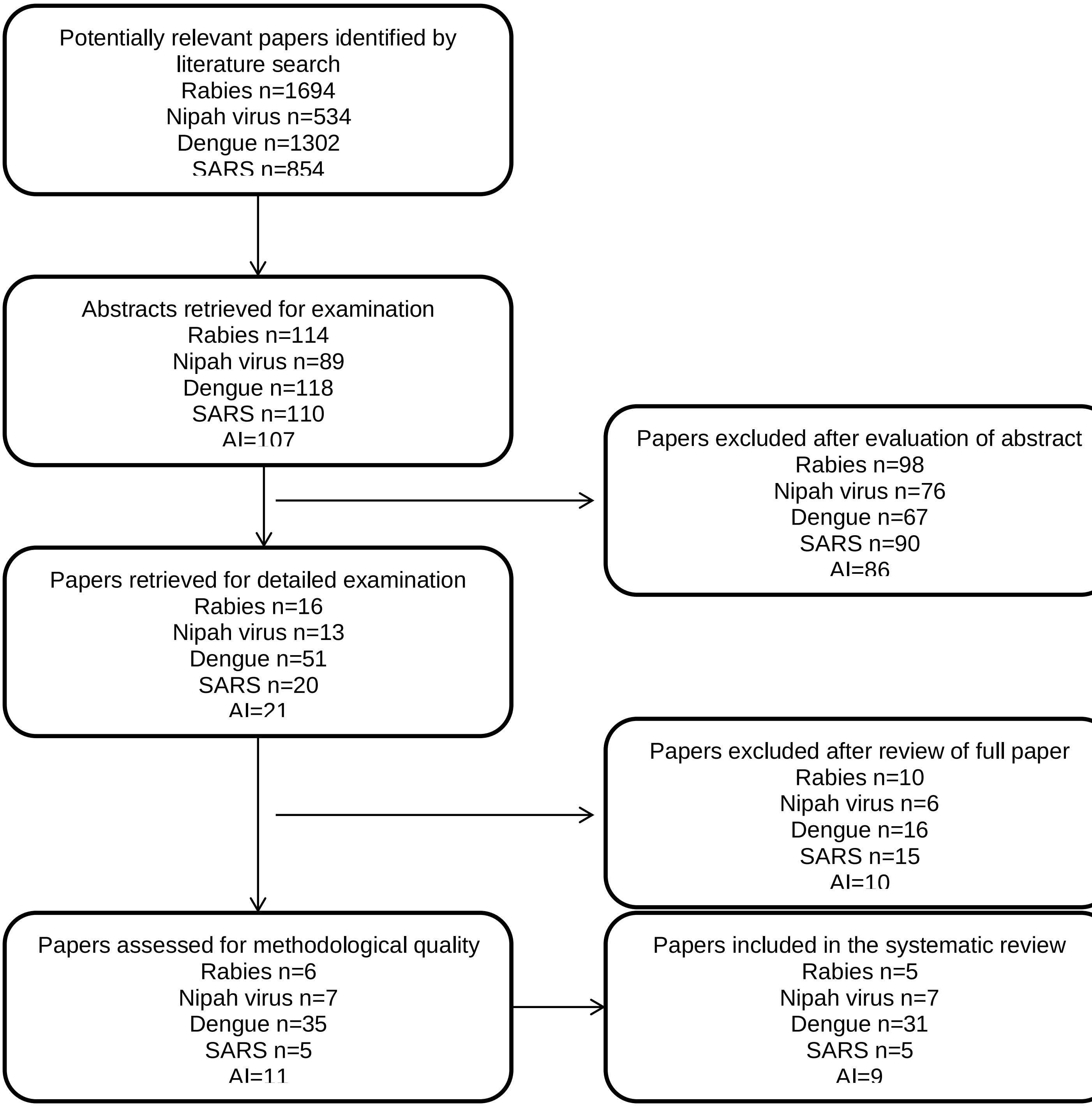
Description of included studies

A total of 5131 potentially relevant titles were identified by the search. Of these, 538 abstracts of potentially relevant papers identified by the literature search were examined, and 417 papers were excluded after evaluation of the abstract (Figure 2). A more detailed examination was conducted of 121 short-listed papers and 57 papers were excluded after review of the full paper. Sixty-four papers were then assessed for methodological quality, after which, seven studies were excluded leaving a final list of 57 papers to be included in the systematic review.

Of the 57 papers included in the systematic review, 19 studies looked at surveillance interventions[25-43] and 44 studies presented data on prevention and control interventions.[29, 30, 36-38, 40, 44-81] Data was available evaluating prevention and control interventions for all 5 emerging infectious diseases included in the review, with the most evidence available for Dengue interventions and the least for Nipah interventions. Evalutions of surveillance activities were available for all diseases except Rabies, where only descriptive studies were retrieved. Details of all the included studies, and the information extracted from these papers, can be found as Appendix IV in Tables 9–20 and 28–35, and a list of excluded studies can be found as Appendix V.

The studies were conducted in a range of Southeastern countries, with the exception of studies on interventions for SARS, where five of the six included studies were from Singapore, and studies for interventions on the Nipah virus outbreak, which were all conducted in Malaysia. With the exception of one study that was a cluster randomised trial,[76] none of the other included studies were randomised trials. Study designs used to evaluate surveillance systems were predominantly retrospective and based on analysis of case series or surveillance data,[28, 31, 32, 41], the exception used a prospective evaluation.[41]The study designs used to evaluate prevention and control activities included:experimental before and after studies,[49, 50, 60, 78, 80, 81] observational prospective comparable cohorts,[38, 39, 44, 45, 47, 48, 52, 53, 55-62, 64-66, 71, 74, 77] prospective cohort studies,[67, 70, 72, 79] retrospective cohorts,[34, 51, 63, 69, 73, 75] and retrospective analysis of interventions using outbreak or surveillance data.[25-27, 29, 30, 33, 35-37, 40, 42, 43, 54]

Figure 2: Flowchart of number of citations identified, retrieved, included and excluded.



Results for interventions targeted at rabies

114 papers were short-listed for comprehensive examination from the original list of 1694 (Figure 2). The majority of the original articles (103) and six systematic reviews were excluded after reading the abstract and an overview of the contents of the paper. The full text articles of 16 studies were retrieved. Reasons for exclusion are outlined in Appendix V and included narrative reviews or descriptive analyses that did not present any data, model-based studies or cross-sectional KAP or seroprevalence surveys with no intervention evaluated. Of the 16 full text articles, six studies were assessed for methodological quality and one was excluded at this stage[82] as it only measured one time point. Five studies have been included in the review (Table 9), two studies from the Philippines on oral canine vaccination in owned dog populations[50, 67] and studies from Thailand[54], Malaysia[68] and Indonesia[81] all describing retrospective data from rabies control programs in response to an outbreak of rabies or an increase in the number of human rabies deaths.

Methodological quality of the studies

Overall the quality of the studies was low. None of the studies presented randomised groups, and criteria for inclusion in the study were sometimes not defined, as were confounding factors. The study by Estrada *et al.*[50] only included a small proportion (10.5%) of the vaccinated group that were tested pre- and post-intervention for seroconversion to assess vaccination coverage. Otherwise, vaccination coverage was estimated by the number of animals vaccinated directly and the number of dogs that accepted bait and subsequently punctured the container. Measurement of the success of the vaccination campaign in the study by Robinson was assessed using dog collars, paint marks or both.[67] Vaccination coverage is summarised as an odds ratio with 95% confidence intervals. It is worth noting that 18% of dogs included in this estimate as vaccinated did not have a vaccination marker but were self-reported by their owners as vaccinated during the campaign. Robinson *et al.* also provide data on the likelihood of vaccination following receipt of campaign information as an odds ratio but fail to provide confidence intervals for their estimate.

The study by Kamoltham *et al.*[54] reports on a five-year rabies control program in the Phetchabun province of Thailand between 1997 and 2001. The authors use the number of human deaths during the program to measure success of the vaccination program, but this is confounded by the increased uptake of post-exposure prophylaxis (PEP) as a result of expansion of the existing treatment regimen. They also mention increasing awareness of rabies through advocacy in provincial schools, television programs, and newspapers, but do not assess these educational initiatives with knowledge surveys before and after the educational campaign.

The data published in Soon *et al.*[68] are from a retrospective case series and presents the number of confirmed cases of rabies in animals in Malaysia from 1946 to 1987, and information about a rabies control program initiated in 1952. Data on evaluation of the vaccination campaign is not presented, other than to report on the decline in the number of cases of rabies in animals, although the denominator of this main outcome data and how it was sampled is not mentioned.

Finally, the study by Windiyaningsih *et al.*[81] also describes rabies control measures in response to an outbreak on Flores Island in Indonesia. Control measures implemented included mass culling and canine vaccination, and post-exposure prophylaxis for exposed cases who had suffered an animal bite. It was difficult to calculate the vaccination coverage as the number of dogs vaccinated for each region was not always provided. It was also difficult to assess the success of the campaign as it was confounded by post-exposure prophylaxis administered to exposed cases.

Rabies – Review findings

Surveillance interventions

From the included papers, data were available for surveillance activities in only two studies[54, 68] Details of the interventions evaluated and the main findings from each included study are presented in Table 10 and Table 11. The study by Kamoltham *et al.*[54] presents the number of potentially exposed cases who received treatment from rabies treatment centres, hospitals and clinics in Phetchabun province, and report that rabies is a notifiable disease in Thailand. A census of the dog population and canine vaccination coverage was also carried out by the Livestock Department of Phetchabun during the program, although this appears to have been on an ad hoc basis collected specifically for the elimination program. The study by Soon *et al.*[68] presents veterinary surveillance data carried out by the Ministry of Agriculture and also mentions surveillance of human cases of rabies infection by the Ministry of Health, as part of the Malaysian National Rabies Control Program. They do not mention how the outbreak was detected or whether any form of surveillance was in place prior to the outbreak. Furthermore, neither of these studies present an analysis or evaluation of their surveillance programs, other than to show a decrease in the number of deaths from rabies infection[54] or to say there was a “decrease in the number of rabies deaths” after the interventions.[68]

The studies in the Philippines[50, 67] and Indonesia[81] do not mention ongoing rabies surveillance. The outbreak on Flores Island was reported by word of mouth by local fishermen when three dogs died.

Prevention and control interventions

Control interventions discussed in the five included studies included canine vaccination,[50, 54, 67, 68, 81] sterilisation,[54] culling of the dog population,[81] public health education,[54, 67, 68] movement restriction of infected dogs[68] and quarantine of newly introduced dogs.[68] Details of the interventions evaluated and the main findings from each included study are presented in Table 10 and Table 11. All evidence on control interventions looked at effectiveness of canine vaccination, administered either through oral baits[50] or by direct injection.[50, 54, 67, 81] The study by Kamoltham *et al.*[54] mentions canine sterilisation, but no data is presented on the latter. Although some interventions included a health education/awareness component,[54, 67, 68] this was only evaluated by Robinson *et al.* The study by Windiyaningsih *et al.*[81] does present data on culling of the dog population in an outbreak setting, although data for all provinces where the intervention was carried out was not recorded. Overall, the available evidence is low quality, and outbreak data is based predominantly on the analysis of a case series using historical controls. The outcome measure used in three studies is the proportion of dogs vaccinated.[50, 67, 81] Kamoltham *et al.*[54] and Windiyaningsih *et al.*[81] also report on human disease indicators such as the number of cases of human rabies. In both studies, attempts to evaluate the impact of the intervention on the numbers of rabies exposures in humans are confounded by concurrent expansion of a cheaper and safer rabies treatment regimen. In the Thai study[54], despite the aggressive vaccination campaign from 1996 – 2001, the number of exposures to suspected and proven rabid animals continued to increase from 1992 – 2000. Inability to enforce movement restrictions of animals, culling of diseased animals and incomplete vaccination coverage contributed to failure to control the outbreak on Flores Island.[81]

Contextual factors

A number of studies reported how behavioural mechanisms by community members and the public impacted on the success of the study. Details of contextual factors extracted from each included study are presented in Table 12. Robinson *et al.*[67] observed that pre-campaign education and advertisements contributed to the success of the program and that good information dissemination impacted on the likelihood to vaccinate. Dogs were more likely to be vaccinated if the household had received campaign information from more than one source (OR=4.45, CI not provided, p=0.04, statistical test not stated), and less likely to be vaccinated if the household had learned of the campaign primarily through posters (OR=0.30, CI not provided, p=0.015, statistical test not stated). Poor understanding of vaccination also contributed to refusal to participate (the perception that the vaccine altered the meat if a dog was kept for consumption).

Good engagement of the community was also vital for the uptake of vaccination, particularly for the owned dog population, as owners had right to refuse. Other reasons for refusing to participate included the owner not wanting to cause injury to the dog from vaccination. Estrada *et al.*[50] also reported a reluctance of owners to have dogs repeatedly bled. The study may also have been compromised as a result of dog owners demanding financial compensation for dogs handed over for rabies diagnosis. Reluctance by members of the public to kill dogs in the Flores Island outbreak[81] perpetuated the outbreak, as some owners moved their dogs to rabies-free districts or sold them at markets to avoid killing them. The practice of fishermen travelling with their dogs and subsequently visiting other islands also aided the spread of outbreak.

Both Kamoltham *et al.*[54] and Windiyaningsih *et al.*[81] mention decentralisation of services in Thailand and Indonesia impacting on the ability to obtain complete data in the former and to control the spread of the outbreak in the latter. Lack of coordination between local authorities made it difficult to contain the infected dog population and prolonged the outbreak. Higher level support and the involvement of the authorities was essential in the success of outbreak control measures because some form of law enforcement was required,[68] particularly where no one claimed ownership such as the stray dog and common dog population.

Summary

In summary, no evidence was available for routine human or veterinary surveillance activities, nor an analysis or evaluation of an existing surveillance program for Rabies. All evidence on control interventions looked at the effectiveness of canine vaccination. Although some interventions included a health education/awareness component, this was only evaluated in one study. Overall, the available evidence is of low methodological quality, and outbreak data is based predominantly on the analysis of a case series using historical controls. The outcome measure used was the proportion of dogs vaccinated in three studies. In one study, attempts to evaluate the impact of the intervention on the number of rabies exposures in humans are confounded by concurrent expansion of the rabies treatment regimen. A number of studies highlighted the importance of pre-campaign education and advertisements to impact on the success of the program, as well as coordination of local services and higher-level support to conduct a successful campaign.

Results for interventions targeted at Nipah virus

89 papers were short-listed for more comprehensive examination from the original list of 534 (Figure 2) of which seven studies were critically appraised for methodological quality and subsequently included in the review (Table 13). Reasons for exclusion are outlined in Appendix V and include papers which were: review articles which did not present any data on interventions, prevalence surveys, risk factor studies, and clinical and outbreak reports.

Two studies were outbreak reports of the Malaysian outbreak epidemic[29, 30] and present an epidemic curve of the number of human cases by the date of onset of their illness. Four studies also discussed the National Swine Surveillance Program and subsequent control measures initiated by the Malaysian Government in response to the outbreak.[26, 36, 37, 40] In the final study,[25] authors discuss an active surveillance initiative for the detection of Nipah virus infected swine in Indonesia.

Methodological quality of the studies

The quality of the data in the outbreak reports[29, 30] was poor and based primarily on a case series with historical controls. Neither study outlined when the control measures were initiated in relation to the progression of the outbreak. Bunning[29] presented the number of human and swine cases of Nipah virus infection (an epidemic curve) over the period that the interventions were initiated but do not provide a denominator for this data.

The studies by Ozawa *et al.*, Muniandy *et al.*, Mohd Nor *et al.* and Arshad *et al.*[26, 36, 37, 40] describe the National Sero-surveillance program initiated post-outbreak to detect any remaining infected pig farms and abattoirs not already depopulated. The number of abattoirs and farms tested and proportion positive for Nipah virus is presented. All studies discuss the sampling strategy of the program, the results of the laboratory testing and subsequent control measures taken.

Nipah virus – Review findings

All published evidence included in this systematic review on surveillance and control interventions is based on the outbreak response in Malaysia and Singapore in 1999. Subsequent to 1999, Nipah virus was identified as causing clusters of disease in humans in India and Bangladesh,[83] countries which are outside the scope of this review.

Surveillance interventions

Details of the surveillance interventions evaluated and the main findings from each included study are presented in Table 14 and Table 15. From the included studies, no ongoing routine veterinary or human surveillance appears to have been in place in this region prior to the commencement of the outbreak. Human and swine surveillance was instigated in Malaysia as a measure of active case finding to guide outbreak control measures (the National Swine Surveillance Program).[26, 36, 37, 40] Swine surveillance was also carried out in Indonesia[25] in response to restrictions on the export of Indonesian pork by other Asian countries.

The National Swine Surveillance Program in Malaysia on farms was carried out till the end of December 2000 to detect and cull additional infected herds, and abattoir surveillance was continued in 2001 and 2002 of all pigs entering abattoirs.[37] While there is evidence that the swine surveillance and subsequent control measures were effective, as Malaysia achieved a Nipah virus -free status by the end of December 2001, no evaluation was carried out and no comment has been made on the feasibility and on-going sustainability of this program.

Despite descriptive reports of on-going surveillance activities such as animal tracking systems (coding of farms, ear tagging and tattooing) to aid trace back,[36, 40] educational programs for farmers and health promotion campaigns,[36] there are no studies that report quantitative data on the functioning of these systems and there has been no evaluation of these systems. Strategies of herd health monitoring and improved farm management practices were also briefly discussed by Mohd Nor.[36]

Prevention and control interventions

A number of control measures were discussed in the seven included studies, which included mass culling, quarantining, movement restrictions, education about contact with pigs and the use of personal protective equipment (PPE). Details of the interventions evaluated and the main findings from each included study are presented in Table 14 and Table 15. All interventions were government driven, with involvement from volunteers from non-governmental organisations, farmers and members of the public.[37]

Evidence is indicative that infected pigs were required to sustain transmission, based on the decline in the outbreak following movement restrictions on the farmed pig population, culling of infected herds and in the case of the Singaporean outbreak, bans on the importation of pigs from Malaysia by the Singaporean government. However, the evidence included in this review is low quality and based predominantly on the analysis of a case series using historical controls.

While there is mention of the total estimated loss to the swine industry in terms of cost,[37] there is no information on the cost of the interventions. The sustainability and feasibility of using these interventions outside of an outbreak situation has not been discussed. The study by Muniandy outlines some future challenges to the swine industry in Malaysia, and makes recommendations for long term reform.[37]

Contextual factors

Details of contextual factors extracted from each included study are presented in Table 16. Several of the studies discussed the enormous impact this outbreak had on the pig industry in Malaysia.[26, 29, 36, 37, 40] The eradication of 1.1 million swine represented about 40% of the swine population in Malaysia in 1999[29] and the number of farms were reduced from 1885 to 829 farms.[36] Many pig farmers lost their livelihoods with the culling of their entire pig farm.

The outbreak caused dramatic changes in the pig industry, with pig farming only allowed in pig farming areas designated by the government. Restrictions on pork products and live pig exportation of Indonesian pigs by governments of Thailand, Singapore and the Philippines prompted the Indonesian government to initiate swine surveillance in Indonesia to restore faith in the Indonesian swine industry.

The transmission of Nipah virus was thought to be related to the movement of fruit bat populations in farming areas with the risk of greater exposure of pig farms to foraging fruit bats, although this has not been confirmed.[37] The authors have suggested that intensification of traditional farming systems, particularly of pigs and poultry, has contributed to environments that enhance transmission of diseases from wildlife reservoirs. Furthermore, while intensification and expansion have been on-going, biosecurity measures, the lack of environmental impact assessments, inadequate pollution and waste management practices have left much to be desired.

Muniandy *et al.* also recommends changes locally.[37] They refer to a traditional practice amongst pig farmers in Malaysia of sharing boars and moving sows from farm to farm and recommend that this practice be discontinued. In fact, it was the fire sale of sick pigs from one farm in Perak that was thought to be responsible for the initial spread of the outbreak.[30]

Ozawa *et al.* also discussed difficulties encountered by the trace back system in abattoir surveillance, pointing to irregularities with the tattooing system.[40] Farm codes were tattooed on the back of the animals stamped by the butchers themselves. Ear notching was later introduced to circumvent fraud.

Summary

In summary, there was no evidence of a surveillance system in place to provide early warning of the outbreak. The only surveillance activities described were initiated in response to the outbreak to guide control measures in Malaysia, and as an active case finding exercise in Indonesia. All evidence on control interventions is based on the outbreak response in Malaysia, which included mass culling, quarantining, and movement restrictions. There is no information on the cost of the interventions. The sustainability and feasibility of using these interventions outside of an outbreak situation is likely to be low, and there is no evidence for more sustainable ongoing activities such as animal tracking systems or health promotion campaigns. Despite many reports of ongoing surveillance activities there has been no evaluation of these systems.

Results for interventions targeted at dengue

The original searches retrieved 1302 potentially relevant articles. This included 15 systematic reviews which were identified during this stage and the reference lists for these were examined for additional references. From this list, 118 papers were short-listed for more comprehensive examination. 87 articles were rejected after perusal of the abstract and full text. Reasons for exclusion are outlined in Appendix V and include papers based on: cross-sectional surveys or reports of surveillance activity with no intervention, narrative reviews with no original data and model-based studies. Thirty-five papers were critically appraised for methodological quality and based on these, 31 papers were included in the review (Figure 2). The studies were categorised by country, urban/rural setting and type of intervention to facilitate analysis. Characteristics of the included studies are detailed in Appendix IV (Table 17 to Table 20).

Six studies evaluated the effectiveness of community-based surveillance programs for dengue. These studies came from different countries (Thailand, Indonesia, Singapore, Viet Nam, Cambodia and Malaysia). [28, 31, 32, 38, 39, 41] Two studies evaluated established national level systems,[28, 32] whilst the remaining four were evaluations of novel or improved systems undertaken at a more local/regional level.[31, 38, 39, 41]

Twenty-six studies report on 28 evaluations of dengue prevention and control activities. Much of the evidence for community based dengue interventions comes from studies undertaken in Thailand[47, 49, 58, 64-66, 71, 72, 74, 76, 79] (n=11) and Viet Nam[38, 52, 53, 55-57, 61, 62] (n=8). Within these countries, studies have been undertaken in a wide range of regions so evidence is available from northern, central and southern provinces. The remaining studies were undertaken in Singapore[44] (n=1), Malaysia[48] (n=1), Myanmar[76] (n=1), Cambodia[69] (n=1), the Philippines[59, 76] (n=2) and Indonesia[45, 70, 77] (n=3).

Three studies evaluated community dengue health education and disease awareness campaigns.[45, 64, 74] A further thirteen studies[44, 47, 49, 55-57, 61, 62, 66, 69-72] used educational components in conjunction with a combination of environmental, biological and occasionally chemical vector control. Five studies[48, 52, 70, 71, 77] evaluated environmental control strategies (including use of screens, covering of water containers, and community clean up to reduce larval breeding sites), the majority included an educational component. A further eleven studies[44, 49, 55-59, 61, 62, 66, 72] included environmental control activities alongside chemical or biological control interventions. Seven studies[55-58, 61, 62, 65] looked at biological vector control strategies (including introduction of either copepods or other biological control agents to water containers); in all studies this was in combination with dengue education and environmental control activities. Eleven studies[38, 44, 47, 49, 53, 59, 66, 69, 72, 76, 79] looked at chemical vector control strategies (including larvicide/insecticide distribution and fogging), either in isolation or occasionally combined with either dengue education or environmental control activities.

Methodological quality of the studies

To summarise the general level of evidence for each type of intervention:

- Surveillance - medium quality (generally appropriate study design (cross sectional studies) and analysis but do not control for confounding factors such as epidemic pattern of disease, changes in population structure , changes in patterns of urbanisation and concurrent disease control initiatives)

- Environmental control - medium quality (small sample size, insufficient follow up periods, inappropriate or no control groups, do not control for confounding factors such as seasonality and epidemic pattern of disease, focus on vector rather than disease outcomes)
- Biological control - high quality (adequate sample size, control for seasonality, appropriate control groups, full description of intervention , full description of baseline characteristics of intervention and control groups, report vector and disease outcomes)
- Chemical control- medium quality for national studies (sample size and follow up periods adequate, do not control for confounding factors such as seasonality), low quality for local level studies (small sample size, no or inappropriate control groups, report vector and disease outcomes)
- Educational interventions – low quality (small sample size, insufficient follow up periods, inappropriate or no control groups, do not control for confounding factors including seasonality and concurrent disesase surveillance and control activities, focus on process outcomes)

A major limitation of the body of evidence evaluating prevention and control activities is the reliance on entomological indices to evaluate program effectiveness, as the correlation of these indicators with clinical indicators is relatively weak.[84] Of these studies, eighteen[47, 49, 52, 56-59, 61, 62, 64-66, 70-72, 74, 76, 77] use larval indices as a main outcome measure, and ten[47, 48, 53, 55, 57, 58, 61, 62, 65, 77] report adult mosquito indices as a primary outcome. Fourteen studies[38, 44, 49, 55-57, 61, 64, 66, 69, 71, 72] used numbers of dengue cases or dengue incidence as an outcome. Two studies[53, 58] reported that clinical indicators of dengue could not be used as no cases of dengue were reported from either the intervention or control site but were able to report outcomes in terms of number of positive dengue serology results. Five studies[45, 56, 57, 61, 74] reported data on knowledge, attitude and practice indicators, five[53, 56, 71, 76, 79] presented data on the uptake or acceptability of the intervention and four[57, 69, 76, 79] presented measures of cost or sustainability of the program.

Seven studies had a follow up of 6 months or less,[44, 49, 59, 64, 70, 76, 77] four of less than one year,[38, 48, 53, 65] and eight had a follow up of less than two years[45, 47, 52, 58, 71, 72, 74, 79]. These studies are unable to evaluate the impact of the intervention as fluctuations may reflect the seasonal and epidemic trends in vector and disease indices seen with dengue rather than any effect of the intervention. Short duration of follow-up also limits interpretation of the sustainability of results. Six studies did not have a control group[45, 49, 69, 70, 72, 79] and one study picked an inappropriate control groups[48] in that the intervention was evaluated based on entomological indices, but the vector was not present in control sites at baseline.

Where activities have been evaluated in outbreak situations it is not easy to demonstrate effectiveness as reduction in the incidence of infection may simply reflect the natural pattern of peak and decline seen in epidemics. This problem is demonstrated in the study by Ang *et al.*[44] which evaluates the use of “carpet combing” insecticide spraying exercises during a dengue epidemic in Singapore. Although results suggest that this activity was able to reduce the duration and peak of the epidemic, they do not control for other confounders such as changes in personal protective behaviour during the epidemic.

Dengue – Review findings

Surveillance interventions

Six studies looked at different aspects of the functioning of dengue surveillance activities. Details of the interventions evaluated and the main findings from each included study are presented in Table 18 and Table 19. One study evaluated a passive surveillance system in terms of its ongoing functioning for monitoring endemic dengue,[31] three studies looked at active surveillance of suspected dengue cases,[38, 39, 41] whilst the other two evaluated the ability of surveillance data to predict or provide early warning of outbreaks or epidemics of dengue which occur periodically in endemic areas.[28, 32] Outcomes used in these studies include the number of dengue cases and/or incidence rates, predictive ability of the system (generally in terms of outbreak or epidemic warning), and sensitivity and specificity of the system. One study[41] reported data on the cost of the surveillance system.

The evaluation by Chairulfatah *et al.* was of the local surveillance system in Bandung, Indonesia.[31] The authors reported significant underreporting of hospital cases to the local Municipal Health office (only 31% reported). Poor record keeping impacted on assessment of the system's timeliness. No other qualities of the system were evaluated (representativeness, positive predictive value). The studies on active surveillance systems evaluated systems based on community reporting[38, 39] and a sentinel GP surveillance pilot to detect suspected dengue cases.[41] The study by Osaka *et al.*[38] was inconclusive, as it seemed to be set up to look at the impact of concurrent interventions (done in conjunction with active surveillance) rather than improved surveillance, as both the intervention and control group received the active surveillance component. No information was provided on the increased cost of active surveillance. Oum *et al.*[39] used syndromic surveillance definitions to conduct community-based surveillance on a number of diseases, including 'haemorrhagic fever' (HF). Their evaluation showed value in their approach, as only 33% of cases of HF had contacted a health facility, with 67% of them being treated at home, although they do not estimate a predictive value positive (PPV) for their definition of HF. The majority of deaths (80%) also occurred at home. The surveillance system also detected two clusters of HF reported in one commune. Other system attributes were not evaluated. The sentinel GP pilot[41] compared a sensitive versus more specific case definition of suspected dengue cases presenting to two clinics. The more specific case definition uses diagnostic criteria for DHF outlined by the WHO, so it is not surprising that a higher proportion of patients were positive by serology (33% vs 7%) and virus isolation (50% vs 15%) using the latter case definition.

Barbazan *et al.* used retrospective surveillance data to show that the spatial analysis would allow focusing control activities on 5% of the months to control 37% of cases, and early warning of epidemics could have been done in advance.[28] Chan *et al.* used web search query data to build a model that estimated 'true dengue activity'.[32] They showed good correlation of their predictive model with retrospective data using datasets from Indonesia and Singapore.

Prevention and control interventions

26 studies report on 28 evaluations of dengue control activities. Interventions evaluated were based on a variety of methods including environmental, biological and chemical vector control, as well as dengue disease awareness campaigns and health education activities. Details of the interventions evaluated and the main findings from each included study are presented in Table 18 and Table 19.

Education interventions

Three studies evaluated purely dengue education programs which did not include any other control activities.[45, 64, 74] Two of these studies, undertaken with textile factory workers in Indonesia[45] and a rural community in Thailand,[64] focused on evaluating measures of community engagement with the program as opposed to changes in vector indices or disease outcomes. Both showed an increase in knowledge amongst participants about dengue symptoms and transmission, and awareness about how to reduce vector breeding habitats. Therawiwat *et al.*[74] (also undertaken in a rural Thai community) measured both knowledge and larval indicators. They showed significant increases in knowledge and self efficacy in control of dengue, along with a 90% reduction in larval indices by the end of the study. There is no data presented by any of the studies on whether effects translated into any impact on the number of cases of dengue.

Environmental control

Four studies evaluated environmental control strategies. One study looked at the provision of new water tanks with solid covers;[52] this study showed a reduction in larval indices (average number of larvae per container) in the new tanks, but no impact on larval indices in old existing containers at the study site. Overall there was not a significant reduction in larval indices. The new tanks showed high levels of acceptability amongst the community. The other three studies looked at the effectiveness of environmental cleanup campaigns in combination with dengue education and awareness activities.[48, 70, 71] Crabtree *et al.* used a strategy based in schools and the general community with use of mass media and targeted activities to promote community awareness.[48] They found a 60% reduction in the number of households in the intervention area positive for Aedes aegypti, however, the vector was not present in the control area at baseline, which effectively meant that there was no control group. The number of households positive for Aedes aegypti increased toward the end of the study period. Suroso *et al.* used a predominantly school based strategy to promote clean up amongst the wider community.[70] They found a 50% reduction in larval indices in households, but only a 35% reduction in households with school children and school buildings. They concluded the program had been less successful amongst school children. Suwanbamrung *et al.* conducted their study in three semi-urban communities and used targeted community education activities to promote clean up campaigns.[71] They showed a 50% reduction in household index and an 80% reduction in container index in the village with high levels of community engagement and dengue control capacity. In the two villages where capacity and engagement were lower they demonstrated only a 15% reduction in these larval indices. None of these studies reported data on the cost of the intervention or provided follow up beyond one year to look at sustainability.

Biological control

Seven studies evaluated a dengue control program that included use of biological control agents. One study[65] is a pilot study of the use of Larvitab© (larvicidal bacteria) in a rural location in Thailand and includes no educational or environmental activities. The study reported a 70-85% reduction in larval indices and a 75% reduction in adult mosquito indices (as compared to only a 10% and 35% reduction respectively in the control group). The other six studies evaluated the use the copepod Mesocyclops as a biological control agent in water containers and also included health education and disease awareness, and environmental cleanup activities as part of the control program. One of these was a study undertaken in urban Thailand[58] that found that the percent of containers positive for larvae went from around 38% to close to 0%, mosquito landing numbers went from around 1 to close to 0, and the percentage of children screened who were dengue sero positive went from 13.5% to 0%. In contrast the percentage of positive containers and children increased in the control area.

The other five of studies evaluating copepods came from Viet Nam and were conducted by the same research group over a period of 15 years in a variety of rural and urban settings across North and Central Viet Nam. This group includes four original trials conducted in different communes[55, 56, 61, 62] and a follow up study looking at the cost and sustainability of the interventions up to nine years post-intervention.[57] The intervention was very comprehensive including use of copepods, environmental cleanup campaigns, the use of microcredit schemes to encourage development of recycling business, and broad community education activities and awareness campaigns. In all four original studies the intervention achieved a reduction in vector indices, reducing larval populations by over 97% 12 months post introduction of copepods and achieving 99% reduction or elimination with the addition of community education and environmental cleanup activities. The studies also reported a reduction in dengue incidence and this was also maintained with no project communes reporting local cases of disease (only a handful of imported cases) since 2003. In contrast larval population and dengue numbers remained present in control areas with figures fluctuating with the seasonal and epidemic nature of the disease. Participants reported a 99.5% rate of willingness to participate and a 97.8% acceptance of copepods.[56] The average cost per person per year of the original program was estimated at $US2, with a marginal cost of expansion of 20c.[55] In the follow up study, the average cost of the program was calculated to be 61c per person per year (equivalent to a total cost of $6,134 annually) in International Dollars.[57] Using a self-developed tool to measure sustainability they found that the project rated 4.42 out of 5 indicating it was highly sustainable.[57] Rates of both vector indices and cases of dengue remained at zero in the original project communes over five years after the end of the original research study.[57]

Chemical control

Eleven studies evaluated some form of chemical control (including insecticides, larvicides, fogging or spraying programs, or use of impregnated nets or curtains). Five of the studies which evaluated chemical methods of control also had an environmental cleanup component to the intervention to reduce vector breeding habitats.[47, 49, 59, 66, 76] There was no systematic difference in effectiveness between these studies and those not including this component. Three studies looked at the use of impregnated nets or curtains.[53, 59, 79] The two studies evaluating nets showed a significant reduction in adult vector indices[53] and larval vector indices[59] but were not able to show a reduction in dengue infections as measured by dengue serology.[53] Madarieta *et al.* reported a significant increase in the number of people using non-intact nets or not using nets consistently over the six month study period.[59] Vanlerberghe *et al.* showed that curtains were well accepted by the community[79] but correct use was not sustainable - follow up observations noted nets with tears/holes, nets not hung and nets being used for other purposes (e.g. storage). No information was presented on dengue infection numbers or costs.

Four studies evaluated the use of a chemical larvicide (Temephos©) in water containers,[47, 66, 69, 76] one study evaluated the effectiveness of fogging or spraying of insecticide targeted at the adult vector[44] and two studies evaluated a combination of larviciding and spraying.[49, 72] Of these seven studies, five measured outcomes in terms of larval indices, of which four studies showed that use of larvicides or insecticides reduced larval indices by between 50-80%.[47, 66, 72, 76] The remaining study, which evaluated use of this method of control during an outbreak as opposed to within an ongoing control program, was not able to show any impact on larval indices.[49] Only one study[47] measured the impact of larviciding on mosquito landing rates and was not able to demonstrate any impact for the intervention. Three studies reported outcomes as numbers of dengue infections.[44, 66, 69] All showed a reduction in dengue cases, of around 50% in urban areas and 80% reduction in the one rural area studied.[66] Ang *et al.* reported that the impact of dengue spraying on dengue notifications was greatest during an outbreak than under endemic conditions.[44] Two studies provided data on cost and sustainability. Suaya *et al.* estimated the cost of an annual larviciding program in Cambodia at 11c per person covered.[69] Phantumacinda *et al.* reported that they only achieved 70-86% coverage in their larviciding program.[66]

Comparisons of control methods

Three studies compared different types of dengue control. Umniyati *et al.* compared a program based on environmental cleanup with repeat insecticidal fogging in an urban setting in Indonesia.[77] They found that the environmental cleanup intervention was more effective than the chemical control program in reducing larval and mosquito indices. Osaka *et al.* compared use of insecticidal aerosol cans with ultra low volume (ULV) fogging in an urban region of Viet Nam.[38] They found that use of aerosol cans for household spraying was more effective (a 71% v. a 52% reduction in dengue cases) and less costly (US$393 v. $US553) than the fogging program.

Tun-Lin *et al.*[76] looked at the use of vector control programs targeted at the most productive container types versus untargeted control programs in urban settings in Thailand, Myanmar, and the Philippines (note that data from Viet Nam was excluded from the review as there was no follow up at this site). In the Philippines, two forms of environmental control were compared. Tyre splitting, water drum cleaning and waste management was compared to a general community clean up and awareness campaign. In Myanmar, introduction of biological agents (dragon-fly nymphs and fish) to the most productive water containers was compared to a blanket approach where all containers were targeted and chemical control (Temephos©) was used intermittently. In Thailand introduction of a biological larvicide (Bti) to the most productive containers was compared to use of chemical control (Temephos©) in productive containers, plus regular emptying of all other containers and occasional insecticide spraying. In all three countries both the targeted approach and the non-targeted approach were equally effective at reducing entomological indices (Breteau index) by 80% in Myanmar and the Philippines and 50% in Thailand. Implementation costs were reported for Myanmar and the Philippines. In Myanmar, the targeted vector control program had lower implementation costs ($4.47 per year per household covered) than the non-targeted campaign to which it was compared ($6.45 per year per household). In the Philippines, the targeted intervention had higher implementation costs compared to the non-targeted campaign ($9.32 v. $2.19 per year per household). In the Philippines high levels of acceptance of the interventions were reported. Coverage of 70% and 73.5% was achieved in the Philippines and Myanmar respectively.

Contextual information

Given the larger number of studies identified that evaluated dengue surveillance or control activities, contextual information extracted from each study were grouped under the following headings for discussion: contextual factors, behavioural mechanisms, and program design. Within each of these broad headings, subcategories have been used to draw conclusions across studies. Details of contextual factors extracted from each included study are presented in Table 20.

Contextual factors

Study context

There were geographical differences in the types of prevention and control interventions evaluated and the location of study sites. Sixteen of the 26 studies included study sites in rural locations. These studies came from Viet Nam[52, 53, 55-57, 61, 62], Thailand[47, 49, 58, 64-66, 74], Indonesia[70] and Malaysia[48], and looked at interventions that used a combination of health education, environmental vector control strategies (mainly focusing on reducing vector breeding sites) and biological vector control strategies (predominantly the introduction of copepods to both public and private water containers). Fourteen studies looked at the effectiveness of control programs in urban settings. This evidence came from Singapore[44], Myanmar[76], Cambodia[69], Indonesia[45, 77], Vietnam[38, 55-57, 85], Thailand[66, 71, 72, 79] and the Philippines[59, 76] and was more likely to be evaluations of chemical forms of vector control (including use of insecticides in public water sources, fogging of dwellings and public buildings and promotion of use of insecticide treated nets).

Four interventions were evaluated in both urban and rural settings; these were impregnated bed nets (a chemical intervention), larviciding (a chemical intervention) introduction of Mesocyclops to water containers (a biological intervention) and community cleanup campaigns (an environmental intervention). Similar levels of effectiveness for all of these interventions were achieved in both settings except larviciding which appeared to be more effective in rural area at reducing both vector indices and dengue rates. Phantumacinda undertook their study in both urban and rural areas of Thailand and had higher levels of volunteer participation in the urban areas.[66]

Seasonality

Umniyati *et al.* compared source reduction of larval habitats with insecticide fogging in both the wet and dry season.[77] Source reduction out-performed fogging at reducing larval numbers in both seasons. In relation to reducing mosquito numbers, source reduction was better than fogging in the dry season but in the wet season the two methods were equivalent. Swaddiwuhipong *et al.* found that a health education and temephos larviciding program was more effective in epidemic than inter-epidemic years.[72] Ang *et al.* reported that the impact of dengue spraying on dengue notifications was greatest during an outbreak as opposed to under endemic conditions.[44]

Water supply infrastructure and environmental management

Crabtree *et al.* reported a lack of piped water supply and significant problems managing refuse due to lack of infrastructure in the rural coastal Malaysian villages as barriers to their environmental and educational program.[48] Butraporn *et al.* reported poor wastewater management and a lack of affordability of piped water in their study as hindering the effectiveness of their chemical and environmental control program.[47]

The six studies [55-58, 61, 62] which included the use of copepods in their intervention commented that use of this method of control is applicable where the major breeding habitats for the vector are large water storage containers (which cannot be easily emptied and cleaned), that are used as stores from which smaller containers are refilled (thereby transferring copepods).

Behavioural mechanisms

Models of behaviour change

None of the included studies refer to specific models of behavioural change being used to design the intervention programs, however all of the studies make reference to the fact that the programs were designed to result in changes in practices to prevent dengue infection and transmission.

Dengue knowledge

Beckett *et al.* evaluated an education program and showed that improvement in knowledge scores was strongly correlated with educational level.[45] Therawiwat *et al.* found that education level and being male were predictive of high knowledge scores.[74] Kay *et al.*[57] showed a direct link between the frequency of household visits by dengue program volunteers, household knowledge of dengue prevention and the practice of dengue control activities. They also found that use of copepods as a biological method of dengue control was lees successful when not combined with health education and awareness building activities. Kittyapong found that dengue education was needed to ensure that the water container covers distributed in their intervention were used properly.[58] Vanlerberghe *et al.*, who evaluated use of insecticide treated curtains, found that disease knowledge was not correlated with uptake or correct use of the curtains[79] and Butraporn *et al.* found that increased knowledge and awareness did not translate to increased use of Temephos© in household water containers or improved waste management.[47]

Perceived importance of dengue

The three studies authored by Kay *et al.*[55-57] report that health volunteers in their interventions were paid a stipend of $US 2-4 per month (approximately 4 days of work) plus given a uniform. In the follow up study[57] they report that these stipends were not motivation for the volunteers. This in fact stemmed from the prestige of the position which derived from the value assigned to these roles by the community based on the severity of dengue as a public health problem. In contrast, the village health volunteers in the surveillance system evaluated by Oum *et al.* were reported to be motivated because they were financially rewarded.[39]

Chairulfatah *et al.* states that the doctors in their surveillance system often wished to postpone reporting until a diagnosis of dengue was confirmed and health municipality officials were often asked to report only patients with obvious dengue haemorrhagic fever or dengue septic shock.[31]

Perceived effectiveness of the intervention

Both Butraporn *et al.*[47] and Vanlerberghe *et al.*[79] reported a link between perceived effectiveness of the intervention amongst community members and continued engagement in program activities, with a decline in the use of Temephos© plus waste management and the use of impregnated curtains over the study period as participants failed to see reductions in mosquito and dengue rates.

Community input, ownership and involvement

In many studies, key community members were identified as leaders or champions for the program and these individuals were involved in developing the intervention and mobilising activities in the wider community. Kay *et al.*[57] compared vector indices and dengue rates in project communes to those in communes which received a rollout of the intervention but which didn't offer communities the opportunity for local input and modification to the program prior to implementation. They report continued absence of the dengue vector Aedes aegypti and reduced rates of dengue in the original project communes whilst the non-project communes had higher rates of both outcomes.

In the chemical control programs, community involvement in the intervention was generally passive, i.e. they received the program. The interventions were designed, coordinated and run by centralised agencies or teams. Community members' involvement was usually restricted to uptake of household strategies such as use of impregnated nets or larvicides, or allowing access to the household for spraying activities. In contrast, community involvement was active in the education, environmental and biological control programs. Community members were involved in the design and planning of environmental cleanup strategies, involved in development and delivery of the health education and disease awareness components of the program and trained and used for the distribution of biological agents and ongoing monitoring and evaluation of the programs.

High levels of community ownership and involvement are consistently reported as an important factor in the success of these control programs; Crabtree *et al.* state that the grass roots community action promoted success of their environmental cleanup program[48] and Suwanbamrung *et al.*[71] reported that their community education and environmental cleanup campaign resulted in a significant reduction in vector indices in all three villages. However, the village with the highest community capacity for dengue control amongst leaders and the general community recorded the lowest entomological and epidemiological indicators. Nam *et al.*[62], Nam *et al.*[61], and Kay *et al.*[55], all report that community leaders mobilised the whole community to take high levels of ownership of the program, which enabled a multi-level community approach to control. Nam[61] report that continuous community input is required into their intervention based around use of copepods and environmental clean up to prevent reinfestation with the dengue vector. Vanlerberghe found that active engagement of the community in promoting continued use of impregnated curtains was more important in increasing uptake than continued educational messages about dengue.[79]

Crabtree *et al.* report spin-off benefits to the community from participating in their intervention.[48] These were increased civic pride, well-being, and more effective networking and self-advocacy with government agencies as a result of their environmental and education based program.

Use of schools to deliver education activities

Suroso *et al.* delivered their educational and environmental intervention primarily through schools.[70] They reported lower reduction in vector indices in school premises and households with schoolchildren, relative to households with no school children, and attribute this to a lack of motivation amongst school children. In contrast, Phantumacinda *et al.* reported that students were better volunteers in their larviciding intervention than village participants,[66] and Swaddiwudhipong *et al.* found that their education program was more effective in schools compared to private households and other public buildings.[72] Kay *et al.* used schools as a key platform for delivering education and awareness activities to both school children and the wider community,[55] highlighted the importance of school children in providing an important service to the community in the inoculation of copepods to water sources as necessary,[57] and reported that teachers and school children were particularly important in the success of clean up campaigns.[56]

Community attitudes toward government responsibilities

Crabtree *et al.* reports that sustainability of their environmental control program in Malaysia is threatened by local attitudes that place responsibility with government agencies to address and enact positive changes in local environment and infrastructure.[48] These attitudes undermine sustainability of changes to attitudes and behaviour regarding environmental clean up to reduce vector breeding habitats. This is in contrast to Nam *et al.*'s evaluation of a biological and environmental control program in Viet Nam which cites the importance of recycling as an economic activity as one of the reasons why clean up campaigns were so successful in reducing entomological indices.[62]

Program structure and delivery

Cost of the intervention

Financial support for all the surveillance systems came, at least in part, from international donors or commercial organisations. The study which evaluated the use of internet sources for rumour surveillance was sponsored by Google who provided access to the data and technical support.[32]Two studies commented on financial constraints to their surveillance system; Chairulfatah *et al.* reported that they could only perform serology tests as opposed to the more definitive recovery of virus tests in their system,[31] whilst Osaka *et al.* reports that an extension of their system beyond a pilot would likely require use of cheaper serology testing.[38]

Adequate investment and resourcing for both start up and maintenance was also frequently identified as an important factor for prevention and control interventions. Beckett *et al.* states that their budget was too low to enable them to reach all community members with their educational intervention.[45] Eamchan *et al.* reports the high price of larvicidal agents (specifically Temephos©) as a potential barrier for ongoing use.[49] Swaddiwudhipong *et al.* which had included this as part of their intervention was forced to drop it during the final (and epidemic) year of their intervention due a lack of funds.[72] Phantumacinda states that ongoing supply of Temephos© is necessary as periodic mass campaigns are less effective and therefore not economical or practical.[66] Phan-Urai *et al.* notes that Larvitab© (like Temephos©) requires repeat dosing at regular intervals.[65] In contrast, the six studies[55-58, 61, 62] which included the use of copepods in their intervention stated that all control tools were locally produced including the copepods which can be farmed locally for minimal cost.

The cost to participants of the intervention may facilitate or inhibit success of the program. Hien *et al.* studied the use of new containers with solid lids that were provided free to the community.[52] Whilst larval indices in these containers were low, the community continued to use many old containers and there was no overall reduction in larval indices. Kay *et al.*[55-57] report their interventions included microcredit schemes for small businesses that were based around recycling and waste removal. These acted as catalysts for sustained environmental cleanup and some of the profits from these activities are reinvested into other dengue control activities.

Acceptability of the intervention

None of the studies evaluating educational, environmental or biological control programs reported issues with acceptability of the program in community participants. Several studies specifically reported high levels of acceptability by the community.[48, 55, 71] The use of copepods in water containers was also well accepted and reported as requiring minimal time and effort to sustain.[57] Phan-Urai *et al.* reports how participants had no complaints about the use of Bti (a biological larvicide) in water supplies.[65] The product was perceived as safe and preferable to Temephos (a chemical larvicide) which was thought to be oily and raised concerns about the use of chemicals in drinking water. Eamchan *et al.* and Phantumacinda *et al.* also reported issues with acceptability of Temephos, including smell, taste and not wanting to place the agent in drinking water.[49, 66] Madarieta *et al.* and Vanlerberghe *et al.* both reported a decline in use or correct use of impregnated curtains over their study to less than 50%.[59, 79] Igarashi *et al.* found that 100% of households found impregnated bed nets simple, convenient and comfortable to use.[53]

Technical support

Pengvanich *et al.* states that a long-term version of their program would need support from authorities not just volunteers. Kay *et al.*[57] state that communes in Viet Nam which received a rollout of their biological, environmental and educational intervention without support from a technical program team achieved lower reductions in entomological and epidemiological indices than the original project sites. In their evaluation of an educational intervention, Therawiwat *et al.* report that interaction between key stakeholders and researchers enhanced reflection and dialogue amongst stakeholders. However, Oum *et al.* reports that that there was tension between the village health volunteers (VHV) used in their surveillance system and official health staff who were often not receptive the VHVs efforts.[39]

Use of targeted v. blanket strategies

Tun-Lin *et al.* found that the targeted intervention used in Myanmar was less costly but equally effective as a non-targeted strategy, whilst in the Philippines, where a strong social intervention component was included in the program, the targeted intervention cost almost five times more than the non-targeted intervention for comparable levels of effectiveness in regards to reduction of vector indices.[76] Kittyapong *et al.* report that whilst targeted vector control could feasibly be rolled out beyond a research program in their Thailand setting it was likely to be too costly to implement.[58]

Meta-analysis

We included a number of outcome measures including household index, container index, Breteau index, the larval population number, larval density index, the mosquito biting rate and the number of cases of dengue infection. Definitions for each of these outcome measures are given in the methods section and further description of the meta analysis can be found in Appendix VII. The first five outcome measures measure Aedes aegypti larval populations in a number of settings (for example, in houses, in containers, as a total population number), the sixth measures the presence of adult mosquitoes, and the final is a measure of clinical infection with dengue virus. The studies varied in size from 61 to 6341 households and 1163 to 2.9 million people (represented by the size of the square in the forest plot), and covered a range of interventions, including environmental, educational, biological and chemical interventions, as well as a combination of more than one intervention.

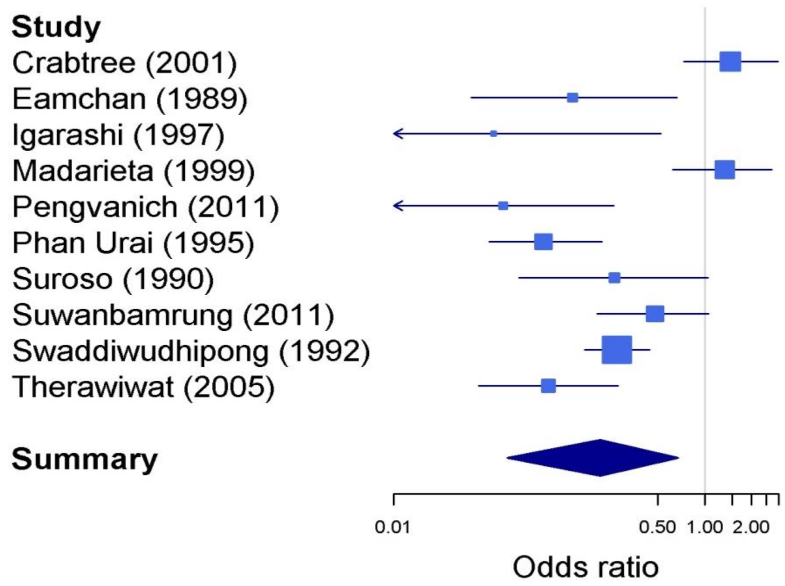
Household index

Ten studies measured household index as an outcome measure. The meta-analysis showed that the dengue control interventions resulted in a statistically significant reduction in the household index giving a summary mean odds ratio of 0.21 (95% credible interval 0.05, 0.68) (Table 21). Despite the forest plot showing heterogeneity between studies, with Crabtree *et al.* and Madarieta *et al.* reporting that the intervention increased household index (Figure 3), the sensitivity analysis showed that the summary mean odds ratio was stable to the influence of each individual study.

Table 21: Mean odds ratio and 95% credible intervals from studies reporting household index

	Mean odds ratio	95% credible interval	
		Lower	Upper
Summary estimate	**0.21**	**0.05**	**0.68**
Between-study standard deviation	1.64	0.82	3.23
Between-result standard deviation	0.71	0.47	1.07
Study left out			
Crabtree (2001)	0.18	0.05	0.51
Eamchan (1989)	0.23	0.06	0.80
Igarashi (1997)	0.27	0.09	0.89
Madarieta (1999)	0.17	0.05	0.48
Pengvanich (2011)	0.27	0.07	0.87
Phan Urai (1995)	0.24	0.06	0.93
Suroso (1990)	0.21	0.05	0.74
Suwanbamrung (2011)	0.19	0.05	0.72
Swaddiwudhipong (1992)	0.21	0.05	0.78
Therawiwat (2005)	0.23	0.04	0.79

Figure 3: Forest plot of odds ratios from ten studies reporting household index; dengue control interventions led to a significant reduction in household index



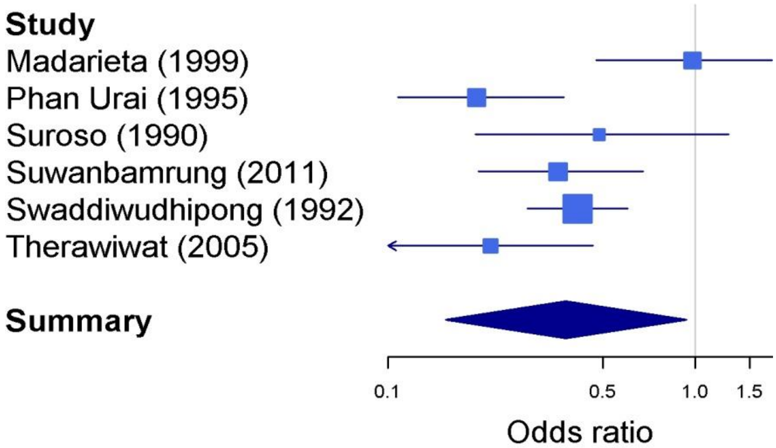
Container index

Six studies measured container index as an outcome measure. The meta-analysis showed that the dengue control interventions resulted in a statistically significant reduction in the container index, giving a summary mean odds ratio of 0.38 (95% credible interval 0.15, 0.94) (Table 22). The forest plot shows heterogeneity between the individual study findings, with Madarieta *et al.* reporting the intervention had no impact on container index (odds ratio=1) (Figure 3). However, the sensitivity analysis showed that the summary mean odds ratio was stable to the influence of each individual study.

Table 22: Mean odds ratio and 95% credible intervals from studies reporting container index

	Mean odds ratio	**95% credible interval**	
		Lower	**Upper**
Summary estimate	**0.38**	**0.15**	**0.94**
Between-study standard deviation	0.92	0.22	2.34
Between-result standard deviation	0.58	0.40	0.86
Study left out			
Madarieta (1999)	0.30	0.15	0.69
Phan Urai (1995)	0.45	0.16	1.30
Suroso (1990)	0.36	0.11	1.26
Suwanbamrung (2011)	0.38	0.09	1.38
Swaddiwudhipong (1992)	0.37	0.09	1.46
Therawiwat (2005)	0.44	0.14	1.41

Figure 4: Forest plot of odds ratios from six studies reporting container index dengue control interventions led to a significant reduction in container index



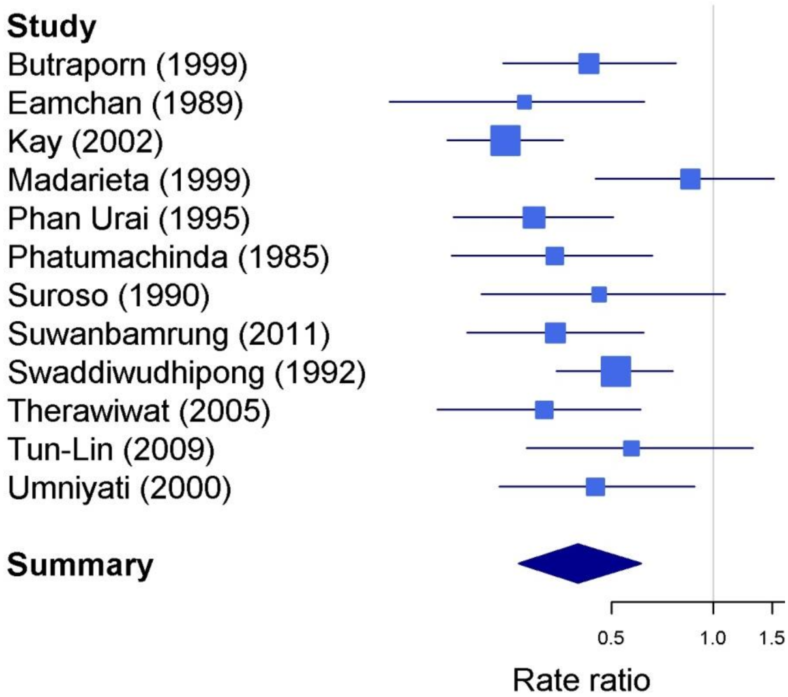
Breteau index

Twelve studies measured Breteau index as an outcome measure. The meta-analysis showed that the dengue control interventions resulted in a statistically significant reduction in the Breteau index giving a summary mean rate ratio of 0.40 (95% credible interval 0.26, 0.61) (Table 23). The forest plot shows homogeneity between studies (Figure 3), and the sensitivity analysis showed that the summary mean odds ratio was stable to the influence of each individual study.

Table 23: Mean rate ratio and 95% credible intervals from studies reporting Breteau index

	Mean rate ratio	95% credible interval	
		Lower	Upper
Summary estimate	**0.40**	**0.26**	**0.61**
Between-study standard deviation	0.53	0.22	1.02
Between-result standard deviation	0.63	0.45	0.85
Study left out			
Butraporn (1999)	0.39	0.24	0.62
Eamchan (1989)	0.42	0.27	0.63
Kay (2002)	0.43	0.28	0.64
Madarieta (1999)	0.35	0.25	0.51
Phan Urai (1995)	0.42	0.26	0.65
Phatumachinda (1985)	0.41	0.26	0.63
Suroso (1990)	0.39	0.25	0.60
Suwanbamrung (2011)	0.41	0.26	0.63
Swaddiwudhipong (1992)	0.38	0.24	0.60
Therawiwat (2005)	0.41	0.26	0.63
Tun-Lin (2009)	0.38	0.25	0.58
Umniyati (2000)	0.39	0.25	0.62

Figure 5: Forest plot of rate ratios from twelve studies reporting Breteau index; dengue control interventions led to a significant reduction in Breteau index



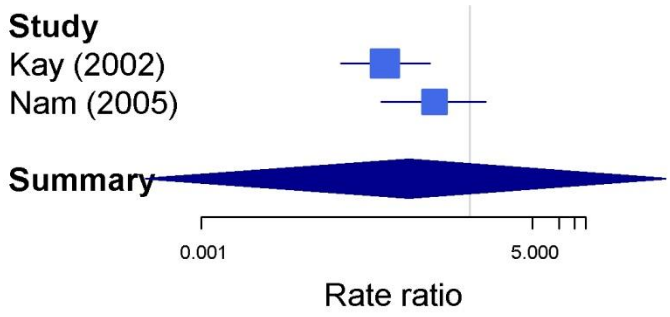
Larval population number

Only two studies measured the larval population number. The meta-analysis showed that the dengue control interventions resulted in a non-significant reduction in the larval population numbers giving a summary mean rate ratio of 0.21 (95% credible interval 0, 156.9) (Table 24). The small number of studies is the reason for the wide credible interval. The forest plot shows homogeneity between the individual study findings (Figure 6). As there were only two studies, a leave one out sensitivity analysis was not performed.

Table 24: Mean rate ratio and 95% credible intervals from studies reporting larval population number

	Mean rate ratio	95% credible interval	
		Lower	**Upper**
Summary estimate	**0.21**	**0**	**156.9**
Between-study standard deviation	3.48	0.16	9.44
Between-result standard deviation	2.15	1.59	2.95

Figure 6: Forest plot of rate ratios from two studies reporting larval population number; dengue control interventions led to a non-significant reduction in larval population number



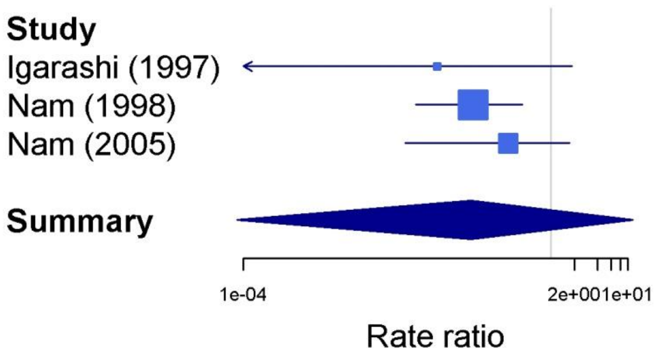
Larval density index

Three studies measured the larval density index. The meta-analysis showed that the dengue control interventions resulted in a non-significant reduction in the larval density index giving a summary mean rate ratio of 0.09 (95% credible interval 0, 11.51) (Table 25). The small number of studies is the reason for the wide credible interval. The forest plot shows homogeneity between studies (Figure 7), and the sensitivity analysis showed that the summary mean odds ratio was stable to the influence of each individual study.

Table 25: Mean rate ratio and 95% credible intervals from studies reporting larval density index

	Mean rate ratio	**95% credible interval**	
		Lower	**Upper**
Summary estimate	**0.09**	**0**	**11.51**
Between-study standard deviation	3.13	0.13	9.19
Between-result standard deviation	0.59	0.01	2.07
Study left out			
Igarashi (1997)	0.10	0.00	70.04
Nam (1998)	0.01	0.00	130.39
Nam (2005)	0.04	0.00	126.22

Figure 7: Forest plot of rate ratios from three studies reporting larval density index; dengue control interventions led to a non-significant reduction in larval desntiy index



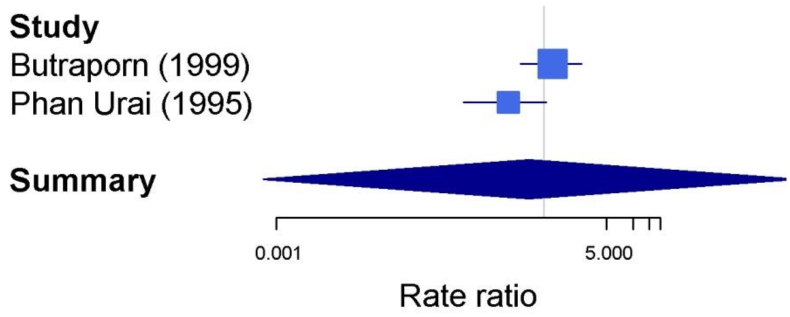
Mosquito bite rate

Two studies measured the presence of adult mosquitoes by recording the mosquito bite rate. The meta-analysis showed that the dengue control interventions resulted in a non-significant reduction in the mosquito bite rate giving a summary mean rate ratio of 0.68 (95% credible interval 0, 634.83) (Table 26). The small number of studies may be the reason for the wide credible interval, as the forest plot shows homogeneity between studies (Figure 8). As there were only two studies a leave one out sensitivity analysis was not performed.

Table 26: Mean rate ratio and 95% credible intervals from studies reporting mosquito bite rate

	Mean rate ratio	95% credible interval	
		Lower	**Upper**
Summary estimate	**0.68**	**0**	**634.83**
Between-study standard deviation	3.51	0.22	9.33
Between-result standard deviation	0.40	0.01	1.45

Figure 8: Forest plot of rate ratios from two studies reporting mosquito bite rate; dengue control interventions led to a non-significant reduction in mosquito bite rate



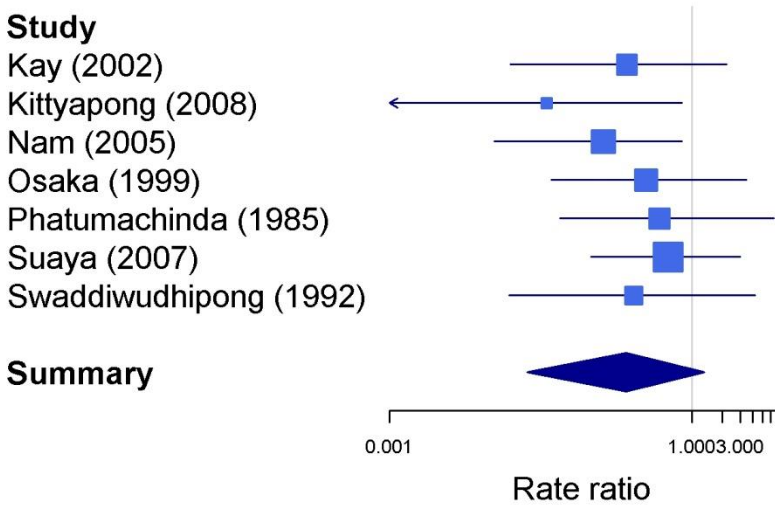
Rate of dengue haemorrhagic fever

Seven studies measured the rate of dengue haemorrhagic fever. The meta-analysis showed that the dengue control interventions resulted in a non-significant reduction in the infection rate giving a summary mean rate ratio of 0.22 (95% credible interval 0.02, 1.32) (Table 27). The forest plot shows homogeneity between studies (Figure 9), and the sensitivity analysis showed that the summary mean odds ratio was stable to the influence of each study.

Table 27: Mean rate ratio and 95% credible intervals from studies reporting the rate of dengue haemorrhagic fever

	Mean rate ratio	95% credible interval	
		Lower	**Upper**
Summary estimate	**0.22**	**0.02**	**1.32**
Between-study standard deviation	1.75	0.11	5.68
Between-result standard deviation	2.13	1.15	3.69
Study left out			
Kay (2002)	0.20	0.01	3.17
Kittyapong (2008)	0.45	0.11	1.60
Nam (2005)	0.26	0.01	2.44
Osaka (1999)	0.15	0.00	2.97
Phatumachinda (1985)	0.16	0.01	2.12
Suaya (2007)	0.09	0.00	2.30
Swaddiwudhipong (1992)	0.20	0.01	1.74

Figure 9: Forest plot of rate ratios from seven studies reporting the rate of dengue haemorrhagic fever; dengue control interventions led to a non-significant reduction in Dengue haemorrhagic fever



Summary of results for meta analyses for dengue control interventions

The results of the meta-analysis showed that overall, the interventions included in this review were able to show a statistically significant impact on larval indices; including approximately an 80% reduction in the proportion of positive households, approximately a 60% reduction in the proportion of containers positive for Aedes aegypti larvae and approximately a 60% reduction in the Bretau index, when results are pooled across type of intervention. Although we anticipated being able to draw indirect comparisons of effectiveness between intervention types, the small number of studies for any one intervention type precluded formal sub-analyses to look at relative effectiveness. However, a narrative interpretation of the forest plots shows no trend in levels of effectiveness by type of intervention, country, urban versus rural context or study size.

Two studies[48, 59] showed inconsistent results (an increase in larval indices as opposed to a decrease), but this difference does not appear related to the type of intervention. The study by Crabtree *et al.*[48] trialled an environmental cleanup intervention; it is a low quality study that is weakened by its inappropriate choice of control area (the mosquito vector was not present in the control area at baseline). The study by Madrieta *et al.*[59] was a small, short, low quality trial of insecticide impregnated bednets. A feature common to both studies tht may partially explain their contradictory findings is that each reported problems with the sustainability of the intervention. After 6 months, 52% of nets were no longer in use and 60% of nets in use had been washed (reducing their insecticidal properties). At the end of the environmental cleanup study, the authors report ongoing waste management issues, and a failure to alter ingrained attitudes that the government should address these issues, rather than seeing them as a community responsibility.

Pooling of results across intervention types estimates that vector control results in approximately an 80% reduction in the rate of dengue haemorrhagic fever, however this result does not achieve statistical significance. Effectiveness does not appear to vary by country or urban/rural context. There is the suggestion of a slight trend to greater levels of effectiveness for interventions incorporating biological vector control methods[56, 58, 61] versus chemical vector control methods[38, 66, 69, 72], but this is not statistically significant. Only three studies[56, 66, 72] included in the meta-analysis reported data on both larval and dengue outcomes. All showed consistency in the direction of the effect across outcomes, however all showed a bigger reduction in larval indice than number of dengue infections. This provides support for use of larval indicators as an intermediate outcome in evaluations of dengue control interventions, but suggests that they cannot be used to directly estimate the impact of the intervention on disease outcomes.

Summary

A substantial body of evidence is available evaluating the effectiveness of dengue control interventions and surveillance activities. The available evidence comes from countries across SE Asia providing confirmation these programs work in a diverse range of geographical and social contexts. A wide range of vector control interventions have been evaluated, including chemical, biological and environmental methods of control. These have been evaluated both in isolation and in conjunction with health education and disease awareness campaigns. The majority of this evidence relies on entomological indices to evaluate programs (as opposed to disease outcomes). Duration of follow-up varied from one month[49] to five years.[55, 61]

A review of included studies evaluating surveillance interventions show that well-functioning surveillance systems can be successfully used to spatially and temporally predict dengue epidemics in Thailand. This result has not been replicated in other countries. Community based surveillance methods appear to offer improvements over hospital/clinical surveillance in terms of sensitivity of the system, particularly in settings where there are significant financial barriers to accessing healthcare that results in under-reporting of dengue case numbers.

The dengue vector is amenable to many forms of chemical, biological and environmental control. The meta-analysis showed that overall, the interventions included in this review were able to show a statistically significant 80% reduction in the proportion of positive households and a 60% reduction in the proportion of containers positive for Aedes aegypti larvae, regardless of the type of intervention. There was also a non-significant 80% reduction in the rate of dengue haemorrhagic fever.

Interventions based on health education, environmental and biological vector control appear to be effective, low cost, well accepted, and sustainable in both urban and rural settings. Interventions based on chemical control in urban settings appear to be well accepted and there is evidence for effectiveness but they are expensive and there is limited evidence on their sustainability. A single study comparing environmental clean-up with repeat fogging found that environmental cleanup was more effective at reducing mosquito numbers than the chemical control program. A study reporting on evaluations in a range of countries showed that targeted environmental and larviciding interventions are as effective at reducing vector indices as blanket interventions and have lower implementation costs. Sub-group meta-analyses by intervention type or rural and urban settings were not possible because of the small number of eligible studies.

Key factors for success in interventions that have shown sustained reductions in entomological indices and disease incidence are the use of behavioural change strategies within their education and awareness programs, combined with support and investment in ongoing environmental management, high levels of community ownership of the program, and sufficient investment and resourcing for both start up and maintenance. There have been few evaluations comparing types of control and the cost-effectiveness of these programs has not been evaluated.

Results for interventions targeted at SARS

The search strategy identified 854 potentially relevant titles, of which 110 were shortlisted (Figure 2), based on details in the title and abstract. Based on perusal of the abstract of full text 96 original references were excluded (reasons are give in Appendix V and papers which were outbreak reports with no data on interventions, narrative reviews with no original data, cross-sectional KAP surveys and model-based studies). Nine systematic reviews that were identified were also excluded, as these focused on either a geographical region outside of the scope of this review(either China, Hong Kong and/or North America), the use of pharmaceutical or clinical interventions (vaccines and lab assays for clinical diagnosis), or the prevention of nosocomial (as opposed to community) transmission. Full text of twenty studies was retrieved, of which five studies were critically appraised and subsequently included in the review (Table). Four of the five were from Singapore[34, 51, 63, 73] with the remaining study originating from Viet Nam[75].

Methodological quality of the studies

All five studies were of low quality and did not control for confounding in their assessment of the effectiveness of the interventions studied. The study evaluating workplace-based surveillance for febrile disease was conducted over too short a timeframe to capture seasonal fluctuation in the incidence of this illness and no data is given on the sensitivity and time-sensitivity of the system.[34] The results from the study are also unlikely to be generalisable to a wide range of workplaces as the study was conducted in a tertiary hospital setting where there were well-established reporting hierarchies and electronic documentation of staff sick leave.

The evidence for prevention and control interventions is derived from descriptive studies based on outbreak data from the 2003 global outbreak.[51, 63, 73, 75] Given the high profile of this outbreak and the laboratory resources available in Singapore and Viet Nam, the datasets used are likely to be comprehensive and capture all symptomatic infections, giving an accurate picture of the epidemic and any impact of prevention and control interventions. However, this type of data also presents major limitations. Firstly, it reduces the ability to determine the impact of these individual interventions from amongst the range of community-based and government strategies that were implemented at that time. Secondly, it is unclear whether any impact is generalisable to future outbreaks, as the studies are unable to control for features unique to the 2003 outbreak. These include epidemiological features of SARS (such as the fact individuals were symptomatic whilst infectious and the relatively low risk of transmission compared to an infectious organism such as measles). Thirdly, they are based on retrospective data and are unable to obtain data on confounders or contextual factors if these were not collected at the time.

SARS – Review findings

Surveillance interventions

Of the papers included in this review, only a single study was identified that reported on ongoing surveillance systems for SARS.[34] Details of the intervention and the main findings from the study are presented in Table & Table . The study evaluates the practicality of post-SARS surveillance recommendations in Singapore. The study focuses on the use of staff electronic medical records for early detection of outbreaks of febrile illness. Although the study is conducted in medical staff at a large general hospital, it is included here as it is being used as an early detection system for outbreaks rather than solely to prevent nosocomial transmission. The study finds that as documented fever is rare in sick leave amongst staff, passive surveillance in healthcare workers would be efficient in identifying outbreaks of febrile illness. Effective markers were found to be clustering of illness, prolonged or repeated absence from work, or the incidence of abnormally high fevers. The authors conclude that such a system is practical and likely to be sensitive in this setting should appropriate indicators be chosen, but that currently the system is not specific. This may lead to many false alarms and ultimately to outbreak "fatigue" whereby people fail to respond to early warning signals. The authors also note that surveillance is time-consuming and resource intensive.

Tan *et al.*[73] provides descriptive information only about the use of temperature screening amongst school children during the epidemic. The study reports that none of the children diagnosed with SARS were detected through this system despite the extensive effort and resources this system required. They describe the benefit of this type of surveillance as psychological, with the purpose being to reassure parents and the public that schools were safe during the outbreak.

Prevention and control interventions

Four studies reported on community-based interventions to prevent and control SARS. Details of the interventions evaluated and the main findings from each included study are presented in Table and Table . Three of the studies are from Singapore[51, 63, 73] and evaluated the effectiveness of home isolation and quarantine protocols and its contact tracing policy. All of the studies were based on retrospective analyses of the same outbreak dataset. The three studies reach the conclusion that the system was effective as it was able to reduce the time from onset of SARS symptoms to isolation from nearly one week to just over a day. They showed that a wide-net approach (i.e. pre-emptive isolation of exposed individuals using a broad definition of exposure) to surveillance and isolation of suspected cases was effective in ensuring progressively earlier isolation of probable SARS cases as the outbreak progressed. They also saw a reduction in the number of secondary infections per case. Only 0.3% of those quarantined broke quarantine. One quarter of all SARS cases had been on quarantine orders prior to diagnosis. Only 0.5% of those isolated went on to develop SARS. It is noteworthy that these interventions were evaluated within an outbreak setting and that a range of other community-focused strategies were also put into place.

A single study from Viet Nam[75] is a risk factor analysis for SARS transmission in contacts of SARS cases in Viet Nam. The study looked at the effectiveness of masks in preventing transmission of SARS from index cases to known contacts (in particular household members and carers). Unfortunately this was a small observational study based on retrospective data and 95% of SARS contacts reported never wearing a mask, so no conclusions could be drawn about their effectiveness.

Contextual factors

Details of contextual factors extracted from each included study are presented in Table31. Escudero *et al.*'s study of a work-based surveillance system acknowledges that electronic documentation of staff medical certificates were important in enabling the system to function in a timely manner and at low cost.[34] The authors also highlight that the study coincided with admission of an isolated case of SARS contracted due to a laboratory accident, which may have both increased awareness of febrile illness amongst staff and improved participation and acceptance rates amongst staff members.

All four studies of prevention and control activities highlighted that there were particular epidemiological features of SARS that made it more amenable to control – namely that patients were only infectious whilst symptomatic.[51, 63, 73, 75] This makes it easier to identify when and where interventions need to be put in place for infected individuals to prevent transmission. It may also increase uptake of interventions amongst non-infected individuals as people are better able to judge their risk of infection.

The three studies evaluating isolation and quarantine policies in Singapore all stated that strong government/political leadership and high levels of community support were important factors in successful implementation of quarantine measures.[51, 63, 73] Other factors identified by these studies as contributing to success in both implementing isolation and quarantine measures, and in halting the epidemic, were good and timely communication both between agencies and outward to the general public and substantial investment to develop information technology systems and laboratory systems capable of providing accurate and timely information over the course of the outbreak. Ooi *et al.* also highlights that Singapore has particular features (small population, high GDP, urban setting) that facilitate the ability to implement large-scale quarantine and states that "imposition of large-scale quarantine should be implemented only under specific situations in which it is legally and logistically feasible".[63]

Ooi *et al.* gives useful information about the public and individual response to the isolation and quarantine policy, stating that stigmatisation of quarantined individuals was reported.[63] Those quarantined were generally agreeable to being confined at home whilst the response was less positive to potential confinement in an institution such as a health centre. Finally, the study indicates that substantial resources were directed toward quarantined individuals, including repeat visits by nurses to deliver health education, the installation of electronic surveillance systems in each household to monitor compliance to quarantine orders, and the use of financial incentives to compensate individuals for lost income. All of these factors are likely to have contributed to the low rate of non-compliance reported in the study.

The study by Tuan *et al.*[75] did not provide any contextual information about why people did not wear masks.

Summary

Five studies were included in the review, one looking at a work-based surveillance system in a Singapore hospital, three evaluating the effectiveness of isolation and quarantine in Singapore as a response to the 2003 SARS outbreak, and one study from Viet Nam reporting on the effectiveness of masks in reducing risk of SARS in people exposed to SARS patients. Overall the evidence is low quality and based predominantly on analysis of case series data from the 2003 outbreak. All three studies that evaluated the impact of isolation and quarantine found this intervention to be effective, however, the major limitation in these studies is that they are all based on analysis of the same routine dataset, and none can control for the impact of the multiple other interventions that were put in place in Singapore at the time of the outbreak. The study reporting on use of masks was an observational study and was unable to comment on whether the intervention was effective as 95% of participants reported never wearing a mask. Important factors contributing to the success of isolation and quarantine policies were good organisation, adequate resources, good communication and public support.

Results for interventions targeted at avian Influenza

Unlike Nipah virus infection, where, to date, the outbreak in 1999 has been an isolated event in SE Asian countries, several outbreaks of avian influenza have been recorded in a number of SE Asian countries from 2004 to 2008. In line with our inclusion criteria, outbreak control measures for each country-specific outbreak were included as long as they had a significant component of community involvement and engagement, even if in concert with "top-down" government-driven initiatives.

The search identified 737 potentially relevant titles, of which 107 papers were short-listed for comprehensive examination (Figure 2). Of these, eleven studies were critically appraised and nine studies were subsequently included in the review (Table32). Reasons for exclusion are outlined in Appendix V, and include papers based on: outbreak reports with no data on interventions, narrative reviews with no original data, risk factor analyses, model-based studies and cross-sectional KAP and prevalence surveys.

Methodological quality of the studies

Of the nine included studies, five evaluated an existing or newly established surveillance system,[27, 33, 35, 42, 43] four studies evaluated prevention and control interventions in the form of education,[46, 60, 78, 80] which was combined, in one study, with behaviour modelling.[80] The surveillance program conducted in Indonesia also incorporated a prevention and control component.

With the exception of the evaluation carried out by Perry *et al.*[42] all studies were of poor quality, with the most common limitation in most studies being inadequate evaluation and assessment of the effectiveness of the intervention, or if the assessment was carried out, the authors failed to present the results of the evaluation. In the study by Bhandari *et al.*, 100 farmers participated in an educational intervention about proper biosecurity measures for the prevention and control of HPAI.[46] However, no information is provided about the knowledge of the participants on this subject matter prior to the intervention, and it is difficult to attribute the results to the intervention.

The study by Desvaux *et al.* conducted poultry market monitoring, surveillance of broilers and hens and surveillance of sentinel villages for the presence of HPAI.[33] The authors admit several constraints identified during the implementation of the program impacted on the quality of the study: insufficient training of field staff (collecting the wrong swabs), biased selection of market places and small sample sizes resulting in the study not being representative. Evaluation of the performance of the system was also needed.

The study by Manabe *et al.* looked at how educational interventions in an intervention and control village influenced awareness relating to H5N1 and the accessibility of healthcare.[60] There were some differences in the intervention and control groups (the control group reported a higher proportion of farmers) and also differences in participants pre- and post-intervention in the intervention commune (greater proportion of participants reported a higher economic level post-intervention). The educational intervention was evaluated by a qualitative survey using face-to-face interviews with a relatively small sample of only 16 participants from the intervention commune.

In an educational intervention in Cambodia, the study by Van Kerkhove *et al.* looked at training programs for village animal health workers following domestic poultry outbreaks in the area.[78] The study evaluated changes in poultry handling behaviours before and after educational campaigns. The study had some limitations. There were differences in sampling methods in the 2006 survey (pre-intervention) compared to the 2007 survey (post-intervention). There were also some demographic differences between the two study populations, and poultry handling behaviours were self-reported, not observed independently.

Educational initiatives were also run in three countries in the Mekong region (Viet Nam, Cambodia and Lao PDR).[80] KAP surveys were conducted pre- and post-intervention. Unfortunately, other than one pre- and post-intervention score on the effectiveness of the intervention in Viet Nam, no other assessment was carried out (or presented) for the Cambodian and Laotian studies, so there is no data presented on disease outcomes.

The study by Samaan *et al.* evaluated a rumour surveillance system based on information from internet news and public health mailing lists and chat rooms.[43] The study covered all countries covered by the WHO Western Pacific Regional Office (WPRO), which includes several countries outside the scope of this review; however, the findings were heterogeneous across country settings.

The final three studies conducted in Indonesia all relate to the same program of participatory epidemiology for the surveillance, prevention and control of HPAI in backyard poultry. The studies by Jost *et al.* and Azhar *et al.* are interim reports of the program.[27, 35] A comprehensive evaluation of the program was conducted by Perry *et al.* for the FAO Evaluation Service.[42] The study is limited by changes in the form of data collection used during the period of evaluation, but aside from this the evaluation is wide-ranging and includes an assessment of the role of all stakeholders involved in the surveillance and prevention components of the program, the quality, clarity and adequacy of the program design, the quality of the data, program outputs and sustainability of the program.

Avian Influenza – Review findings

Surveillance interventions

Five papers detailed surveillance initiatives, three of them[27, 35, 42] presenting data for the same active surveillance program established in Indonesia in 2006. Details of the interventions evaluated and the main findings from each included study are presented in Table33 and Table34. The studies by Jost and Azhar are early reports of the establishment of the system and a three year report of results, respectively.[27, 35] A comprehensive evaluation was conducted by Perry *et al.* in 2009 as part of the FAO Evaluation Service.[42] The evaluation detailed the establishment of "participatory disease surveillance"(PDS), based on principles of participatory epidemiology, i.e. the application of participatory methods to disease surveillance. Participatory epidemiology recognizes that local people have very rich and detailed knowledge about the animals they keep and the infectious and zoonotic diseases that affect their livelihoods and endanger human health. The system focused on the detection of HPAI in the backyard poultry sector (defined by the FAO as sector 4) on a village-wide basis by veterinary surveillance officers, where it was commonly believed the majority of HPAI virus was harboured. It was later expanded to have a prevention and control component. The program was successful in training up a number of Master Trainers, who subsequently delivered training to more than 2,000 surveillance officers. In its three years of operation, it was operational in 76% (341) districts in Indonesia, 27/33 provinces, covering 25,525 villages where surveillance activities had been completed,[27] 1455 of these resulting in diagnosis of HPAI. As of March 2009, infection status of villages was determined as 'infected with HPAI' (2.5%, 490/19,673), 8.1% (1598) suspected infected, 3.1% (612) controlled and 86.3% (16,973) apparently free of infection. The authors comment that the surveillance system enhanced existing passive surveillance systems and addressed a gap in surveillance.

The study by Desvaux *et al.* focused on targeted surveillance of markets, semi-commercial poultry farms located in former outbreak areas, sentinel village monitoring to strengthen surveillance at village level, and serological surveillance of domestic duck farms.[33] The study did not detect HPAI in the market (0/712) or farm (0/51) samples. Market monitoring: samples were collected in seven provinces. Interviews were conducted in 52 villages and on 23 farms, which were subsequently classified according to their risk of having faced an HPAI outbreak. 14/70 (20%) premises were not suspected, 3/70 (4%) were classified as low probability, 18/70 (26%) were classified moderate probability, 35/70 (50%) high probability. The authors identified several constraints during the implementation of program that impacted on the success of the study – lack of motivation of provincial staff, limited capacity of the central team to compile and analyse the data generated, weak diagnostic capabilities and the reluctance of farmers to have animals sampled. They also state that selection of animals in market places was biased and that sample sizes were below defined levels and hence not representative, which may explain the zero detection rate of HPAI in markets and on commercial farms.

The study by Samaan *et al.* used rumour surveillance to analyse rumours generated primarily by the media and email and evaluate if the rumours could offer timely assistance to potentially affected nations, prompt countries to undertake preparedness measures, and inform public and international community about relevant events.[43] Rumours were followed up by email or telephone request to the relevant WHO country office to investigate their veracity. A total of 40 rumours were identified from 20 countries and one Special Administrative Region. 23% of the rumours were confirmed to be true. The authors conclude that this type of surveillance was successful in informing public health action, and was relatively inexpensive to conduct.

Prevention and control interventions

Five studies evaluated education based avian influenza prevention and control interventions. Details of the interventions evaluated and the main findings from each included study are presented in Table33 and Table34.

Four studies were identified where education and training were the main component of the prevention and control interventions, all of them were conducted in the Mekong region, which comprises Viet Nam, Cambodia and Lao PDR. The programs were aimed at communities in rural settings, focusing on increasing awareness of HPAI,[46, 60] motivating people to access healthcare earlier[60] and encouraging a change in hygiene and poultry handling behavior.[78, 80]

The study by Bhandari *et al.* conducted training to 100 farmers who then served as demonstrators for a model of proper biosecurity measures for the prevention and control of HPAI.[46] The authors report that no outbreaks have been reported in the communities in the project areas since the intervention. The program was evaluated in more depth using the funder's own model, the Participatory Self-Review and Planning Toolkit, but the authors do not give details of the tool kit or the evaluation process.

The studies by Manabe *et al.*[60] and Van Kerkhove *et al.*[78] are both before and after intervention studies in comparable cohorts, the former in two agricultural communities in Viet Nam, the latter in two southern provinces in Cambodia. Baseline and post-intervention KAP scores were calculated by Manabe; they also reported differences in the frequency of health and hygiene behaviours between the intervention and control groups.[60] The authors state a greater proportion of participants reported receiving information from a health care worker or a friend after the intervention, and more people were likely to seek early access to healthcare after the intervention. Habits such as touching and eating dead or sick poultry were reported both pre- and post-intervention. Van Kerkhove *et al.* also describes increased reporting to village chiefs, but not to the animal health officer.[78] Awareness of HPAI was high, but understanding of transmission was still low. While there were some improvements to basic hygiene practices and reduction in risky poultry handling behaviours, some risky behaviours still persisted (allowing children to play with poultry, proper treatment of poultry in the household environment).

The study by Waisbord *et al.* was a large undertaking, with training delivered to 3840 district and commune women's union officers in Viet Nam, 810 village promoters in Cambodia and 93 reporters and editors in Lao PDR.[80] The authors provide the number of people, districts, farmers, trained, as process measures. Only in the Viet Namese study do they report pre- and post-intervention KAP scores, reporting an increase from 54% to 92%. Nine percent of farmer households in Cambodia set up model farms after participating in the study, and in Lao PDR, AI coverage on TV and radio improved in both quality and quantity.

The HPAI program in Indonesia began as separate PDS and PDR (participatory disease response) teams, but was later rolled into combined surveillance and response officers. The surveillance component of the program was successful in detecting HPAI, and the PDSR education component also achieved good coverage (29,476 education meetings held with community leaders, 10,093, 6,804, 103,832 and 9,971 meetings held with groups of community members, other organizations, individual households and persons from commercial enterprises, respectively).[27, 35, 42]

Contextual factors

Details of contextual factors extracted from each included study are presented in Table35. Some recurring themes emerged in several of the studies analysed. Several studies reported changing behaviours and customs was difficult,[33, 42, 60, 78] particularly for residents of a rural area with a one-time educational intervention.[60] Van Kerkhove *et al.* report that educational efforts that succeeded in raising awareness and knowledge about the disease did not always succeed in increasing the likelihood of reporting of suspected disease to the authorities (only to community leaders).[78] Perry *et al.* also reported the difficulty in implementing poultry movement control in Indonesia in general, but particularly in the backyard poultry sector.[42] While database recorded movement control was implemented for all HPAI confirmed cases, discussions held with farmers in field visits showed clearly that selling of surviving chickens was widely practiced. Lack of cooperation was also reported in the study by Desvaux *et al.* from farmers who were reluctant to have animals bled for studies.[33]

Nevertheless, they also reported other benefits and strengths of the programs, such as better collaborative networks both at a local level as well as between agencies, sometimes enhancing existing national systems already in place.[42] The PDSR program in Indonesia had very positive impacts on revitalising veterinary services in Indonesia, and in particular in strengthening the local animal health services (Dinas), as well as empowering communities' access to public services. Manabe *et al.* acknowledged the importance of the involvement of local healthcare workers and administrators in H5N1 education and outreach, and that the main impact of the educational intervention was to increase people's trust in local health care providers.[60] Waisbord *et al.* commented that training brought commune council people together and provided the opportunity to network and cooperate more closely in the future.[80] However, it became apparent that the PDSR response alone was insufficient and unlikely to contain and eliminate the disease for a number of reasons: inability to offer compensation to encourage culling, inability by the officers to enforce movement control, inability of the farmers to buy cages and feed to restrain poultry). The program evaluators advocated the need for transition into more sustainable and responsive animal health services.[42]

Summary

Evidence for surveillance interventions of HPAI was identified in programs in Indonesia and Cambodia. The PDSR program in Indonesia has been very successful in training surveillance officers and detecting HPAI in backyard poultry. It has also added value to existing veterinary health services in Indonesia. Conversely, results from the surveillance interventions in Cambodia were equivocal because of several constraints that impacted on the success of the study. Prevention and control initiatives were identified in Cambodia, Viet Nam, Lao PDR and Indonesia. Several programs were not evaluated in terms of final outcomes (only process outcomes were used), or if evaluated, the results have not been published. Several studies identified risky poultry behaviour despite the educational intervention and efforts by disease control staff to contain and eliminate disease for a number of reasons. The need to transition to more sustainable, long -term animal health services was also discussed. Despite this, a benefit of these programs has been to strengthen local collaborative networks and bring people together.

Discussion

Rabies

Surveillance interventions

None of the five studies included in this section of the review present any ongoing community-based human or animal surveillance interventions for rabies, and we did not find other evidence for community-based surveillance interventions. Both of the studies with successful rabies control programs required coordination and cooperation among government and provincial services. Kamoltham comments that rabies is reportable in Thailand, and this is also true of other countries in SE Asia.[86] It is possible that surveillance of rabies is not suited at a community level. With the advent of cheaper and safer human vaccines and the development of more economical regimes for human post-exposure treatment (PET), most Southeast Asian countries are able to administer PET through rabies treatment centres, hospitals and clinics similar to those discussed in the paper by Kamoltham,[54] and surveillance of human cases of rabies through these health provision settings would be a reasonable and feasible approach.

In recent years, the WHO has taken the initiative to develop a regional strategy for the elimination of human rabies transmitted by dogs and advocate for rabies control programs in SEA. Rabies control activities in a number of SE Asian countries are now government-driven with the involvement of government officials, health workers and community members.[86]

Prevention and control interventions

The majority of human rabies is transmitted by dogs through human-animal bite injuries. Models for rabies control programs summarised in this review were based on use of a number of control interventions, including vaccination of animals, restriction of movement of animals, removal of unrestricted animals (culling) and health education. However, the results of the studies included in this review would suggest that mass canine vaccination is the mainstay of successful canine rabies control programs. This has been shown to be the case in a number of other countries throughout the world [87]. Estrada showed oral baits to be an acceptable[82] and successful[50] method of vaccine delivery to vaccinate dogs that was easier to administer than injection. Studies conducted in other countries support this evidence, particularly in the stray and ownerless (common) dog population.[88]

These interventions require high level support and coordination for their implementation.[54, 68, 81] Inability to implement these strategies properly contributed to failure to control the outbreak on Flores Island.[81] Legislation to enforce these interventions is also an essential component of rabies control strategies but in recent years, the WHO has also developed and standardised innovative control tools and techniques that may help support future control programs.[89]

The reduction in the number of deaths from rabies in the study by Kamoltham is noteworthy, and is likely a result of a combined effect of expansion of the PET regimen in humans as well as the dog vaccination campaign.[54] This reduction in the number of human deaths due to the increased uptake of the PET for rabies has also been documented in other Asian countries.[90] However, the number of rabies exposures are increasing in many countries, which may be explained by the finding that the use of effective dog control programs for dog rabies elimination has become rarer in developing countries.[91]

None of the studies evaluated the cost benefits and cost-effectiveness of rabies control interventions, particularly in comparison to the cost of patient expanded treatment (PET) regimen used in these countries. Canine vaccination has been shown to be a comparatively inexpensive and ethical way to control the disease in animals and prevent human exposure and illness in model-based studies, especially in resource-limited countries,[92] more so than the use of tissue-culture vaccines used in post-exposure prophylaxis.

Contextual factors

A number of studies showed the importance of education and good information dissemination, as well as the form of campaign information, on the likelihood of owners to vaccinate their pets. This has been backed by other studies,[92, 93] who have shown that 70-75% of dogs are accessible to control measures, particularly vaccination, if the approach is adapted to the dog-man relationship and the community is fully involved in the rabies elimination program.

Higher level support and the involvement of the authorities was also essential in the success (or failure) of both outbreak control measures and routine canine vaccination, because some form of law enforcement was required, particularly where no one claimed ownership such as the stray dog and common dog population. Lack of coordination between local authorities made it difficult to contain the infected dog population and prolonged the outbreak.

Nipah virus

Surveillance interventions

The Nipah virus outbreak in Malaysia was initially thought to have been illness due to Japanese encephalitis (JE), a mosquito-borne illness, and early control efforts focussed on mosquito source reduction and administration of a JE vaccine.[29] An epidemiological trace-back study conducted by scientists from the CDC and the AAHL with the collaboration of local veterinarians later identified Nipah virus as the causative agent. The lack of an established early warning system that incorporated some form of ongoing monitoring of herd health hampered the prompt identification and control of the outbreak, and would certainly have impacted on the magnitude of the outbreak.

Swine surveillance implemented during the outbreak and after the outbreak ceased was shown to be effective in detecting infected herds. None of the studies discussed the cost of the surveillance system, or the feasibility of an ongoing system. A sustainable, ongoing and structured monitoring system for Nipah virus as well as other animal diseases would reduce the impact of any further outbreaks of zoonotic disease. We found no evaluations of surveillance initiatives post the 1999 outbreak; nor any assessment of costs or other attributes such as the functionality of these systems.

The study by Ozawa *et al.* presented trace back systems in several Asian countries.[40] The study comments that trace back systems are not well developed and marking of animals for trace back is practised only in a limited number of countries in specific areas or zones and for specific purposes only. A comprehensive herd monitoring system would need to incorporate some form of identification system to be able to trace back and isolate an infected animal from a particular farm.

Prevention and control interventions

All control measures discussed in the studies were emergency measures used in response to the Malaysian Nipah virus outbreak. They included culling, movement restrictions, quarantine, PPE for farmers and all persons coming into contact with infected pigs (the military, healthcare staff), health education and practices of farm-gate biosecurity (disinfection, isolation). The sustainability and feasibility of using these interventions outside of an outbreak situation has not been discussed and it is unlikely that some of the more extreme interventions are appropriate for routine use.

Our review found some evidence of proposed long-term sustainable prevention and control measures. New guidelines proposed by the Department of Veterinary Services, Malaysian Ministry of Agriculture, to restructure the industry in line with designated pig farming areas and "good animal husbandry concepts" were to be implemented in each State.[37] Muniandy *et al.* and Aziz *et al.* also outline recommendations for future reform in their paper, which were subsequently discussed at a regional seminar on Nipah virus infection held in Kuala Lumpur in 2001 and jointly organised by the OIE and the Department of Veterinary Services in Malaysia.[26] These include policies and protocols for sound farm management practices, which would incorporate farm-gate biosecurity (i.e. quarantine of new animals brought onto the farm, exclusion testing to establish disease status) and would require the engagement of the pig farming industry. Other preventative measures include outbreak preparedness plans for the management of future disease outbreaks and laboratory diagnostic capability. It is unclear how much progress there has been in this area as our review did not find any evidence to show the implementation of any of these measures.

Contextual factors

The outbreak came at enormous political and social cost to Malaysia. The importance of Nipah virus as a newly emerging viral disease in the SE Asian region cannot be understated. While the disease was eradicated from pigs in Malaysia, its natural history suggests there is an on-going need for preparedness for the potential of further outbreaks of Nipah virus in the region. The challenge for Malaysia and other countries in the Asian and Oceanic regions will be to implement a herd monitoring system and control strategies that are acceptable and sustainable, and the need to develop their own preparedness plans.

Dengue

Surveillance interventions

Some evidence was available evaluating surveillance activities for dengue, although we would agree with the recommendations from an earlier systematic review[94] that more prospective studies are required to determine the most appropriate dengue surveillance system capable of providing early warning of epidemics. Six studies looked at dengue surveillance at a number of levels, ranging from community level to reporting to the provincial health services. From the results presented in Oum *et al.*, it appears that a considerable proportion of people with symptoms consistent with dengue haemorrhagic fever do not access healthcare and are treated at home.[39] Furthermore Chairulfatah *et al.* found significant underreporting to the local public health office of cases that do seek healthcare.[31] These results have implications for the estimation of the burden of disease of dengue fever as well as actioning of control activities in response to hyper endemic activity.

The study by Pang *et al.* shows the usefulness in incorporating GP sentinel surveillance utilising 'point of care' testing to assess suspected cases of dengue haemorrhagic fever in a timely fashion for those cases that do access healthcare.[41] However, this study was trialled with two GP clinics in an urban setting within the Kuala Lumpur area of Malaysia. It is unlikely that this approach will be applicable in a rural setting where people are less likely to go to a doctor, and confirmatory testing is costly and logistically challenging.

The two studies utilising surveillance data were useful in predicting outbreak activity and spatial clustering of outbreaks.[28, 32] However, the spatial analysis has not taken into account other factors accounting for spatial clustering of outbreaks. Such approaches are also only as good as the underlying data they use. In countries such as Singapore, with well-established surveillance in place and good government support for health services, surveillance information is likely to be robust. Other developing countries in need of surveillance improvements could not use this approach.

Prevention and control interventions

The majority of studies reported outcomes in terms of larval or mosquito indices rather than disease outcomes. There has not been much attempt to look at the correlation between dengue vector and disease indicators. Long term absence (or low rates) of the vector does appear to translate into reduced disease incidence, however, in the short-term vector and disease outcomes do not appear to be well correlated.[84] As such reliance on larval or vector indices as the primary outcome measures poses a limitation in terms of evaluating the impact of these strategies on dengue control and the burden of dengue illness in this region given that the majority of studies had follow up periods of less than two years. Short duration of follow-up also means results can be confounded by seasonal and epidemic trends in vector populations and dengue incidence.

Two studies reported the use of serology to measure rates of dengue of infection and showed that rates of dengue seropositivity were higher than rates of clinical dengue infection. This provides interesting evidence for a high incidence of subclinical infection and supports the idea that there is a silent reservoir of disease. This has large implications for the evaluation of both dengue surveillance and control activities, as evaluations based on clinical reporting will underestimate rates of dengue.

The dengue vector, Aedes aegypti responds to control via a variety of methods, and successful programs are fairly homogenous in the extent to which they are able to reduce larval indices over short time periods (less than two years). This finding concurs with the results of three earlier systematic reviews that have looked at the effectiveness of dengue vector control interventions on reducing entomological indicators.[15, 95, 96] Choice between methods of vector control for a given setting may rest on factors such as feasibility, cost and sustainability, as well as contextual factors such as cultural and community acceptance (see next section), factors which have been poorly explored in the included studies.

Chemical options for vector control appear to be better suited to epidemic or outbreak situations. The higher cost of chemical control relative to environmental and biological vector control, plus the need for repeat dosing makes them a less sustainable option for ongoing vector control, particularly in rural areas. However evidence from Cambodia showed that a program based on twice yearly larviciding and dengue awareness activities prevented an increase in dengue incidence over five years, indicating that their use may be more relevant in urban areas where water and waste removal infrastructure is better developed. Larviciding (targeting breeding sites) has been studied more than insecticiding (where adult mosquitoes are targeted), the latter has mainly been used in outbreak scenarios indicating it is unlikely to be an option for long-term control. Trials of insecticide treated curtains indicate that this intervention is unlikely to be sustainable for a number of reasons, including poor use and maintenance of the curtains.

High quality studies conducted in Viet Nam showed that control interventions based around biological, environmental and education components can maintain their effectiveness in reducing entomological indices to the point of local elimination of the vector and in reducing cases of dengue infection over sustained periods of time (10 years).[57] Copepods (natural predators of mosquito larvae) were introduced into water containers to reduce larvae numbers. They can be locally produced, are low cost and have a higher level of acceptability as compared to Temephos©. They have been shown to be effective in both rural and urban areas. However, their use seems best suited to contexts where water is sourced predominantly from large communal water containers, and these containers represent the major breeding habitat for the mosquito. Use of copepods has always been evaluated in conjunction with environmental and waste management activities. These activities have been a core component of most dengue control interventions that have been evaluated and are highly successful if high levels of community involvement can be achieved. They are appropriate for use in both urban and rural settings, and clean-up targeted at the most productive vector breeding sites is as effective as a blanket approach at lower cost.

Unfortunately there are few direct comparisons of dengue control programs. A narrative interpretation of the forest plots generated in the meta-analysis suggests that there is relative homogeneity of effectiveness across types of vector control intervention, country, and urban v. rural context. Based on a single study[77] that compared environmental cleanup to a fogging intervention, the environmental cleanup intervention was more effective during the dry season at reducing larval and vector numbers, however the interventions were comparable during the wet season. This supports the suggestion that chemical interventions may be most suited to outbreak/epidemic situations[44, 49]. For ongoing control, targeted interventions (where specific containers, buildings or areas are identified to receive the intervention, rather than trying to achieve blanket coverage) appear to offer comparable levels of effectiveness but at a lower cost.[38, 76] Targeted strategies obviously rely on having good epidemiological data to ensure that the right sites are identified.

There are few studies that have tried to replicate findings from successful programs in other contexts, and few evaluations of interventions that have been rolled out as regional or national programs. This inhibits the ability to comment on the feasibility and sustainability or even likely effectiveness of interventions outside a pilot study or research context. An earlier systematic review of the functioning of vector control operations found a number of limitations to current programs including a lack of personnel, expertise and budgets, difficulties engaging communities and almost no monitoring and evaluation.[96] There is an urgent need for evidence on how findings for successful interventions can be better translated into effective practice.

Contextual factors

The studies included in the review reported a range of contextual factors, behavioural mechanisms or intervention features that either improved or inhibited the effectiveness of the program. High levels of community engagement are necessary for dengue control interventions to be effective. Barriers to community engagement that are reported in the studies include the perception that dengue is not an important public health issue or that the proposed intervention is not effective. This highlights the importance of education and communication about both dengue and the intervention prior to roll-out in the community. It was also shown that knowledge alone did not automatically translate into improved dengue control behaviours and centrally coordinated environmental cleanup or temephos distribution activities were required to reinforce use of control methods. A barrier specific to community involvement in environmental cleanup activities is a belief that these activities are a government responsibility. Conversely, establishment of these tasks as economic activities, through use of microcredit schemes for small recycling businesses, promoted engagement with this activity. Recycling is not a new concept in Viet Nam; it is not clear whether this strategy would be successful settings where rates of recycling are currently low.

Factors that promote high levels of community engagement include the use of multiple methods of communication and education, repetition of education and awareness activities (rather than one-off sessions), use of existing community groups to promote and deliver intervention activities (in particular schools), and engagement of community members at all stages of the interventions; planning, delivery and evaluation. High levels of community ownership and responsibility for ongoing control activities (in particular environmental management) also have spin off benefits for the community not related to dengue control, including greater advocacy skills and an increase in civic pride. Unfortunately none of the studies provided clear descriptions or rationale for how they selected key community groups or leaders and none provided information on the content of their education and awareness activities or any models of behaviour change on which these had been based. This limits the ability to generalise findings to other social and cultural contexts or adapt successful programs for trial in other locations. It should also be noted that the highest quality evidence was undertaken in Viet Nam which has a fairly hierarchical culture that may have facilitated dissemination of information and increased social compulsion to engage with project activities.

There was only limited evidence for the sustainability of interventions. However, in studies with more than two year follow up periods, factors that promoted sustainability included broad community involvement across different levels (rather than isolated groups), and a sense of community ownership of and pride in the control program. Where activities were embedded into the economic activity of the community (e.g. support for recycling businesses) this also improved sustainability. However, it was also noted that community based programs still need support from authorities and cannot be solely based on the efforts of volunteer individuals and community groups. We would also add that it is unclear the extent to which being part of a research project with access to a highly skilled, motivated and engaged research team contributes to levels of effectiveness.

Kay *et al.*[57] reported a lower level of effectiveness for their intervention when it was rolled out as part of a regional program. This has implications for the use of any of these methods of dengue control as part of a larger program. It is well recognised that adequate resourcing for both start up and maintenance of interventions is important to ensure that the program functions well and communities maintain engagement as without this effectiveness is compromised.[94] Although some interventions are low cost per person covered, the total cost may still be large. It would be worth exploring mechanisms to offset these costs as was done in the Viet Namese studies where some of the profits from recycling businesses were put back into community dengue awareness activities.

SARS

Surveillance interventions

We found little evidence of evaluations of ongoing laboratory, animal or human surveillance systems set up in many countries in response to the SARS outbreak in 2003, nor any assessments of regional surveillance networks or linkages between countries in the Southeast Asian region, given the geographical restrictions placed on the scope of this review.

The single study by Escudero *et al.* of work-place surveillance within a hospital in Singapore was tested within a very structured work context, within which there was access to electronic staff leave records.[34] It is unclear whether this system would work in a more loosely structured work environment. The absence of electronic systems would also increase the labour resources required for such a system. The lack of specificity and the possibility of “false outbreaks” which could eventually lead to fatigue amongst the staff and agencies involved in responding to potential outbreak situations limit its applicability as an ongoing surveillance system in its current form.

The study reporting on use of temperature screening amongst school children during the epidemic describe the benefits of this type of surveillance as psychological.[73] A similar argument has been made for the use of temperature screening at airports[97] which was also costly and had a very low yield in terms of detecting SARS cases. Whilst it is important to avoid negative reactions and panic amongst the community during outbreaks, these screening systems are an expensive (and ongoing) investment and it is unclear if they could be implemented in more resource constrained settings.

Prevention and control interventions

Three of the four studies[51, 63, 73] included in this section of the review focused on contact tracing and quarantine protocols. While the fourth study[75] looked at the effectiveness of personal protective equipment to prevent infection, the quality of the study was poor and the results of the study were of limited value. We did not find other studies reviewing other prevention and control measures (for example, handwashing, temperature screening, closure of workplaces and schools, education campaigns).

The three studies from Singapore all used the same outbreak dataset, and reach similar conclusions that the system was effective in ensuring progressively earlier isolation of probable SARS cases as the outbreak progressed. They also saw a reduction in the number of secondary infections over time. As SARS cases are only infectious whilst symptomatic, and they become more infectious over time, it is logical that this strategy would have been successful in helping to contain the outbreak in Singapore. Indeed the outbreak was brought under control. However, a range of other community-focused strategies were also put in place, including entry and exit screening at airports, market closures, temperature screening in school children and a variety of media health education campaigns, alongside the host of strategies put in place within healthcare facilities. Because of this, the studies are unable to estimate the independent effect of this particular intervention in stopping the outbreak, and no attempt has been made to analyse the size of the effect of confounding and interaction on the authors' results. Furthermore, although the system was sensitive (a quarter of all SARS cases had been on quarantine orders prior to diagnosis) it was not specific (only 0.5% of those isolated went on to develop SARS) making it highly resource intensive per SARS case detected.

Results from the study by Tuan are of limited value. As 95% of the contacts reported never using a mask, the study is underpowered to detect any beneficial impact from using this intervention. As such no conclusions about the effectiveness of this intervention can be drawn. Earlier systematic reviews of the use of masks and other personal protective equipment to prevent transmission of infectious agents have also been unable to draw firm conclusions about the effectiveness of this approach to control.[98]

Contextual factors

We are limited in the ability to generalise the findings about these interventions to detect and/or prevent spread of SARS because four of the five studies that were included were from Singapore, considered an "economically advanced country" with high GDP and level of education, and other particular features such as an urban setting and a small population. It has strong government and political leadership and good levels of community support. A significant proportion of its public are proficient with information technology. The challenges with implementing surveillance of SARS (and other respiratory diseases) in other Southeast Asian countries with less capable national agencies and healthcare institutions will be to engage with community-level healthcare workers and clinics to implement some form of symptomatic or sentinel non-confirmatory surveillance system.

The success of quarantine and home isolation measures in Singapore was in part due to the capability of the Singaporean government to commit significant financial resources to enforce this policy with random phone checking, electronic camera surveillance, nurse visits and financial incentives. It is unlikely these strategies would work in a resource-challenged country, either due to a lack of financial commitment from the government, the lack of technology (telephones, cameras), or a less well developed infrastructure. This is likely to be particularly true for rural and remote areas. There are also particular social and cultural features of Singaporean society that may have contributed to the high levels of acceptability and compliance with quarantine and isolation measures. Finally, tolerance for this approach outside a high profile outbreak scenario is likely to be low.

Avian Influenza

Surveillance Interventions

The PDSR program in Indonesia has been very successful in detecting HPAI in backyard poultry and allowed a clear and accurate picture of the disease status of HPAI in this sector.[42] It has also added value to existing veterinary health services in Indonesia and proved to be a good investment, not just for AI, but also for other animal diseases. Perry *et al.*'s evaluation found a disproportionate focus on the backyard poultry sector 4, as farmers have considerable interaction with small-scale commercial farms (sector 3). For this reason, surveillance efforts need to cast a broader net and greater engagement of the commercial poultry sector is required. It is unfortunate that the study in Cambodia by Desvaux *et al.* had several methodological limitations, as it has been the only one to present information on surveillance of commercial poultry and duck farms.[33] Both studies were able to classify villages according to their risk of either having faced an HPAI outbreak[33] or the probability of HPAI infection,[42] allowing prioritisation of control activities. Perry's report also showed that the majority of visits were scheduled or 'active' surveillance (87%) as opposed to passive surveillance (13%), but were more effective in detecting disease.[42] Surveillance also identified sources of infection (traders, unsafe disposal of carcasses and contaminated vehicles).

The intensive surveillance program in Indonesia required considerable financial investment from external donors and it is unlikely that resource-challenged countries such as Cambodia and Lao PDR would be able to roll out a similarly extensive program. Surveillance programs would have to be setting-specific and tailored to the needs and funds available of the host country. A further challenge for surveillance of HPAI is to transition the achievements gained in the program into a sustainable national system that continues to be accepted. Other than the studies presented in Cambodia and Indonesia, no evidence was found for animal or human surveillance at a community level in the other countries included in this review.

The study by Samaan *et al.* indicated that rumour surveillance based on internet sources is timely and low cost but although it's sensitivity has been demonstrated it is not clear whether the system is specific enough to be of use.[43] Detection of too many "false" outbreaks will limit the credibility of the system. Nevertheless, pilot studies of low cost systems such as this are an important avenue of research to try and extend surveillance coverage to areas with lower levels of information technology, laboratory and healthcare infrastructure.

Prevention and control interventions

Evidence for prevention and control interventions were reported in programs in Cambodia, Viet Nam, Lao PDR and Indonesia. Awareness of HPAI and education regarding risky poultry handling behaviours were common themes in the educational interventions. While the training and education seems to have been well-received, it did not always translate into behaviour modification or change. As some programs were not evaluated, it is difficult to say which components of the intervention have failed and why. An internet rumour based surveillance system represents a potential low cost and timely form of surveillance to inform immediate public health action, but may be limited in its applicability, across the region as it depends highly on the level of engagement of local public health professionals with the chat forums and mailing lists searched, and journalists awareness of AI and quality of reporting. It needs to be demonstrated whether it is capable of detecting outbreaks in resource limited areas where citizens may not have access to the technology on which the system relies.

The prevention and control interventions in the PDSR program in Indonesia had limited success in controlling and eliminating HPAI, for a variety of reasons. Veterinary officers have no legal mandate to enforce culling or movement restrictions of dead or infected poultry. Furthermore, in the absence of financial compensation for loss of livelihood, farmers are under no obligation to report mortality or sickness in animals and will not comply with the requests of disease control officers, and therefore interventions need to be setting-specific. This comes back to the theme of "participatory epidemiology" – engagement of the farmer in decision-making through education and training, but the corollary, that is, recognition of the needs of the community are also essential.

Contextual factors

The studies stressed the importance of engaging local people and civil societies, who can provide rich institutional resources to support difficult changes in health and animal husbandry practices. It was also recognised that local people have rich and detailed knowledge about the animals they keep and the diseases that affect them (termed "existing veterinary knowledge"), whilst researchers often do not know or understand the local context. In SE Asian countries, the poultry industry involves an enormous and diverse set of small entrepreneurs, linked in a number of business relationships and with a wide range of players. Effective HPAI control will require engagement at all levels of the industry. Issues such as financial compensation (or the lack of) for control activities will have to be addressed before governments can enforce policies around culling, movement restrictions and quarantining.

Conclusion

Several common themes emerged when reviewing the literature for the five diseases examined in this systematic review. On the whole, the quality of the studies was low to medium, with evidence on evaluations of surveillance and prevention and control programs not always identified. Evidence on the costs, cost benefits, feasibility and sustainability of these programs was also scarce. Interventions tended to have been evaluated as research or pilot projects rather than as ongoing activities. Most interventions had only been trialled in a single context and durations of follow up were short, limiting the evidence for generalisability and sustainability of findings. Given the limited quantity and quality of information on surveillance and control programs for emerging infectious disease in this region, the findings and conclusions drawn from this review should be interpreted with caution. Absence of evidence for an intervention should not be interpreted as it being ineffective or less effective in specific contexts, rather there is no available published evidence. Similarly, absence of evidence for contextual factors should not be taken to reflect their influence, or otherwise, over the functioning of programs, but rather a lack of reporting.

Appraisal of effective programs showed that sensitivity to local context, attitudes and mores is essential. Many studies were identified where the intervention was not successful or partly successful because of local cultural or social factors. The need for adequate resourcing was also a common theme. Finally, investment in national veterinary and local animal health services appears to have been either absent, insufficient or not given enough priority. Linkages between this sector and human health need to be strengthened. The framework of 'One Health', proposed by the FAO, WHO and the OIE, to expand interdisciplinary collaborations to address the animal-human-ecosystem interface, needs further investment for these diseases in this region.

Rabies

Evidence evaluating both veterinary and public health surveillance systems for rabies was not identified; this lack of evidence may in fact reflect the fact that there are no or poorly functioning systems in place. Canine vaccination appears to be the most promising strategy for control, but investment in education is essential for a successful vaccination campaign. Rabies control was more likely to be successful when canine vaccination was used in conjunction with other control strategies. However, canine control activities (including vaccination, sterilisation and culling) are not always popular with the public, and country-specific cultural attitudes can be important. Treatment programs for exposed cases continue to be expanded which has helped to reduce mortality rates, but not rates of exposure to rabies.

Nipah virus

While the concepts of farm-gate biosecurity and herd health monitoring were discussed at the OIE/DVS meeting, there has not been any further progress on recommendations set out at the meeting or any recent publications discussing progress in this area. All evidence on control activities has been in response to the outbreak. Data from targeted and ongoing surveillance as well as the cost and feasibility of the interventions will be essential to guide future prevention and control efforts outside of an outbreak setting, both of which have been absent from the literature. Local traditional farming practices will have to be considered when drafting policies and protocols for sound farm management practices.

Dengue

The dengue vector is amenable to short term control via a variety of vector control methods. Currently there are not enough studies of the same intervention type, nor many direct comparisons of interventions to be able to assess whether one form of intervention is more successful than another at reducing larval indices.

Where vector control is sustained, this appears to result in a reduction in dengue cases. However, many of the existing studies evaluating dengue control interventions do not have a long enough follow-up period to enable an assessment of the sustainability. Environmental management to reduce larval habitats is an effective way at reducing vector numbers and can be used in both urban and rural areas. It is often supplemented with the use of either biological (such as copepods) or chemical (such as Temephos©) larvicidal agents. The latter is reported as being less acceptable due to problems with smell and taste. The former has good evidence for sustainability and is low cost, but the suitability of this control method in settings where water is not obtained from large centralised tanks has not been evaluated. Disease education is important but in the absence of other coordinated activities does not result in improved control practices.

There is limited evidence for the use of interventions outside research projects. Studies that have evaluated roll out of interventions to regional programs indicate that effectiveness may be reduced, possibly due a lower level of access to technical expertise and lack of involvement of communities in the program planning stages. Sustainability requires communities to take ownership of ongoing control activities. High levels of community engagement require multiple methods of communication and activities.

SARS

Little evidence was available on evaluations of ongoing laboratory, animal or human surveillance systems implemented after the outbreak in 2003, nor any assessments of regional surveillance networks or linkages between countries in the SE Asian region. The single study of hospital records-based surveillance was conducted within a very specific setting and not generalisable. No community-based surveillance interventions were identified.

The majority of studies examining control interventions were based on the analysis of outbreak data to review contact tracing and quarantine protocols. While control measures were shown to be effective, they did not control for confounding from other community-focused control strategies. No other studies reviewing other prevention and control measures were identified. Most included studies were from Singapore, an advanced country that is very urbanized, and with a small population. Control measures were costly and cannot be applied in resource-challenged settings. The geographical scope of the review posed a limitation on the evaluation of control interventions for SARS as it excluded studies from China, Taiwan and Canada, countries that were most impacted by the outbreak of SARS in 2003.

Avian influenza

There appear to be large investments in several countries in SE Asia on training, educational and surveillance initiatives, but evidence on the evaluation of these programs was not always identified. Surveillance in the backyard poultry sector has been successful in identifying HPAI in backyard poultry flocks, but needs to be broadened to include other sectors of the commercial poultry industry. Surveillance interventions have had added spin-off benefits of strengthening the local animal health services. Prevention and control efforts have proved more challenging for a number of reasons. Successful educational campaigns have not always translated into behavior modification and change. Involvement of and recognition of the needs of the community are essential in addressing these barriers to change. Community programs have been largely reliant on external funding, and the challenge will be to incorporate them into the national process where the programs can become institutionalised in a sustainable way.

Limitations of the review

A major limitation of this review was that our literature search was limited to studies published in the English language, which will have excluded studies conducted in local languages and published in local non-English journals. The geographical scope of this review (the ten member countries of the ASEAN) also poses a limitation that had a great impact on the analysis of interventions for SARS as it excluded studies from Hong Kong, Taiwan, China and Canada; countries that were most impacted by the outbreak of SARS in 2003. Transmission of SARS in countries within the geographical scope of this review was mainly within the hospital setting,[99] thus much of the available evidence concentrates on the prevention of nosocomial transmission and protection of healthcare workers, rather than evaluation of community-based strategies, and was excluded from the review.

A further limitation is that the review only included studies with empirical data and therefore, at least for some of the diseases, this resulted in a small number of included studies. Practical implications may also need to consider data from mathematical modelling studies, which were excluded from this review. Although these studies are essentially hypothetical, inferences from these studies may provide useful insights into the epidemiology and transmission of disease and can be used to predict the likely coverage, effectiveness and cost-effectiveness of different possible interventions under a range of scenarios.

Another limitation is that cross-sectional surveys of knowledge, attitude and practice regarding disease and prevention and control activities were excluded as outside the scope of this review and are listed in Appendix V. Although they do not test the effectiveness of an intervention they may provide information useful to plan the successful implementation of interventions. Similarly, our exclusion of purely qualitative studies limits our analysis of behavioural contextual factors that may affect the effectiveness of interventions. Our review has shown that these factors strongly influence a person's decision to act contrary to the clear health messages being delivered, or to engage with a program's messages and activities. The reasons that govern such behaviour and the decision-making process may be better elicited through an appraisal of qualitative research.

Some of the studies excluded from the review were done so on the basis that they were only available in abstract form and a full copy of the study could not be obtained for review. As such we are aware that there is potentially more evaluations that have been conducted than have been fully reported. If there is a systematic bias in which studies are published, this will bias review results.

Finally, countries such as Thailand (a developing country) and Singapore (considered an 'advanced country'), have well established national health agencies and healthcare institutions. We excluded from the review studies that evaluated purely government-driven national health institutions or systems, however, some "top-down" government-driven initiatives may include local level community involvement and engagement in concert with the centrally coordinated response, especially in outbreak situations. As many studies do not or cannot provide a detailed description of every element of the intervention it is possible that we did not identify some activities with community-based elements. Exclusion of these studies also meant we were unable to undertake a broader analysis of a country's health systems which is relevant in the context of community-based health interventions transitioning into a national approach.

Implications for practice

Several implications for practice can be derived from the findings of this review. There are a number of general recommendations that relate to all five emerging or re-emerging infectious diseases included in the review, as well as recommendations specific to each disease. Each recommendation is assigned a level of evidence according to JBI criteria for evaluation of effectiveness studies (see Appendix VI). Where information on interventions was not available we are unable to comment on whether they are likely to be effective or what contextual factors may influence this. This should not be taken as evidence that these strategies are ineffective but rather represents a gap in our current knowledge.

The studies included in the review provide no detailed evidence for risk assessment in development of the interventions trialled (or indeed any program planning tools/frameworks utilised). This limits the ability to draw conclusions about which interventional approach may be most appropriate for a given setting where no situational analysis has or can be conducted.

Linkage of animal and human health systems for detection and control of disease is essential for zoonotic infectious diseases as animals represent the main reservoir of infection. We found only limited evidence for programs based on the framework of 'One Health'. Some contextual information is available showing linkages need to be multi-level and be compatible with economic activity to be successful. The evidence for this is discussed under each disease. However, no information was provided in the studies on how linkage of these systems is best achieved.

General

- Community based prevention and control strategies are more effective if they have access to central coordination and support. (Level 3).
- Surveillance data can be used to build predictive models of outbreaks and transmission that can be helpful for planning control activities. (Level 3)
- Linkage between veterinary and public health surveillance systems improves timely detection of outbreaks. (Level 3).
- Higher levels of effectiveness are achieved where the community is involved in all stages of the program (planning, delivery and evaluation). (Level 2). Program activities can be delivered and coordinated through existing community groups. The use of schools is a good channel as long as school children are fully engaged in the program. (Level 3).
- Community participation in programs is higher where people perceive the disease as an important public health problem and are well informed about the control program and perceive it as likely to be effective (Level 3).
- Interventions that conflict with the economic activity of communities are poorly tolerated, whilst those that are compatible, or offer new economic opportunities, are well received (Level 2).

Rabies

- Rabies vaccine to stray and common dog populations is effective at reducing rates of rabies in canine or human populations if high levels of coverage are reached. (Level 3). Vaccination coverage is increased if comprehensive and effective education campaigns are used that are delivered via multiple channels. (Level 3). Owned dog populations tend to be easier to vaccinate as their owners have a vested interest in their well-being. (Level 3). Canine vaccination without incentives/enforcement) is not as effective in achieving good coverage of vaccination. (Level 3). Vaccination coverage may increase if financial compensation for destroyed animals was offered (Level 3). Improvements in communication between public health and veterinary systems would make it easier to monitor canine vaccination. (Level 3).
- Culling of dogs is not socially acceptable in countries in this region and there is active resistance to this strategy. (Level 3).
- Improved treatment protocols have been effective in reducing the number of rabies deaths in humans potentially exposed to rabies through animal bites. (Level 3)
- Evaluations benefit from human rabies being notifiable, even where monitored via a passive surveillance system based in PET distribution clinics and hospital cases. (Level 3).

Nipah virus

- Advance planning for disease outbreaks (outbreak management plans) improves timeliness of response. (Level 3)
- Swine surveillance and culling of infected animals and herds is effective at detecting and halting outbreaks of Nipah virus (Level 3). Financial compensation for destroyed animals makes culling very expensive but increases tolerance and support of the strategy amongst farmers (Level 3).
- Effective monitoring of herd health requires adequate number of laboratory submissions as an early warning system, laboratory capacity, and a high level of farmer and veterinarian awareness of disease. (Level 4).
- Animal tracking systems used in swine surveillance required permanent forms of animal marking (such as ear notching) to reduce attempts to defraud the system. (Level 3).
- A cross-regional plan of trace back systems between Asian countries makes sense as much as local and national systems to track the movement of pigs. (Level 4).
- Pig farming industry should be managed differently including:
    - Policies and protocols for sound farm management practices, which incorporate farm-gate biosecurity (i.e. quarantine of new animals brought onto the farm, exclusion testing to establish disease status) and would require the engagement of the pig farming industry. (Level 4).
    - Traditional practice of sharing boars or moving sows from farm to farm should not be practiced. (Level 4).
    - Separation of animal farms from orchards and fruit and vegetable growing areas where fresh food is grown for human consumption. (Level 4).

Dengue

- The dengue vector is amenable to short term control via a variety of vector control methods. Where control is sustained this results in a reduction in dengue cases. (Level 2).

- Interventions using copepods, environmental clean-up and education activities are effective at reducing larval indices, mosquito indices and incidence of dengue to the point of local elimination. The strategy is low cost and sustainable. It is effective in urban and rural settings but is most suitable in settings where water is obtained from large central tanks. (Level 2).
- A combination of environmental vector control and education without biological agents is also effective at reducing larval and mosquito indices. (Level 3).
- Environmental vector control and larviciding of breeding habitats is effective at reducing larval indices, incidence of dengue and dengue morbidity in both urban and rural areas. (Level 3). Targeted control where the most productive habitats are targeted for environmental clean-up or introduction of copepods is equally effective but less costly than a blanket program which includes all containers. (Level 2). The use of chemical larvicides in water supplies is less well tolerated by communities than biological control agents. (Level 3).
- Chemical vector control based on fogging is equally effective but more costly than environmental vector control and there is no evidence for its sustainability. (Level 3). The use of chemical fogging is well suited to the control of outbreaks. (Level 3).
- The use of impregnated curtains is not sustainable. (Level 3).
- Educational interventions offered without coordinated environmental clean-up activities or distribution of chemical or biological larvicidal agents do not reduce vector indices or dengue incidence. (Level 3). Education needs targeting and repeat sessions to improve knowledge and awareness, but this alone does not translate to improvements in control practices. (Level 3).
- Environmental and waste management are important to the success of interventions. To ensure the intervention is sustainable communities need to take ownership and responsibility for these activities. Providing opportunities for economic activity in this area can support this process. (Level 2).

SARS

- Passive surveillance in healthcare workers can be used to detect outbreaks of febrile illness. The cost and timeliness of the system will depend on the extent to which staff medical records are electronic. (Level 3)
- Contact tracing and large scale isolation and quarantine is effective in reducing the time to isolation of suspected cases and reducing the number of potential contacts in urban areas, however its use is best suited to outbreak situations and should be restricted to situations where it is economically, logistically and legally feasible. (Level 3). Successful implementation of contact tracing and isolation requires good organization, good communication and high levels of public support. (Level 3).

Avian Influenza

- Communities have veterinary knowledge that can be successfully tapped to identify high risk areas or potential outbreaks amongst poultry. (Level 3). Village (backyard or farm) based surveillance is successful at identifying high risk areas and potential outbreaks. (Level 3).
- A multi-country rumour surveillance system based on web sources was successful at identifying outbreaks in a low cost and timely manner. (Level 3).

- Educational programs are successful at increasing awareness and knowledge about HPAI but have a lower impact at improving basic hygiene and risky poultry practices. (Level 3). More successful programs offer multiple opportunities for people to engage and access the program; one-off educational interventions do not work as well. (Level 3). Increased knowledge and awareness of HPAI increases rates of identification of sick poultry amongst community members, but not reporting to local authorities. (Level 3).
- Culling of sick poultry is effective at preventing spread of HPAI but is not well received by community members in the absence of financial compensation. (Level 3).

Implications for research

The review identified many important gaps in the available evidence. Suggestions for future areas of research which would benefit from methodically sound quantitative studies are discussed below. General comments applicable to all five emerging or re-emerging infectious diseases have been listed as well as suggestions specific to each disease.

General

- Better evidence is needed on the structure, functioning and outcomes of current local and national surveillance systems for emerging infectious diseases. Ideally these should be long-term studies capable of assessing sustainability rather than short pilots. Further evaluations of promising novel methods of surveillance utilising technology such as mobile phones or the internet should also be undertaken.
- Minimum datasets should be designed for use in outbreaks, to ensure more comprehensive data collection that will allow for more rigorous evaluation of the impact of outbreak control measures.
- Evaluations of prevention and control programs need to be longitudinal rather than cross-sectional and report on the impact on disease outcomes, health knowledge and practices, as well as information on the acceptability, cost and sustainability of programs.
- Education and awareness programs should be designed and evaluated against models of behaviour change to facilitate extrapolation of findings to other contexts.
- Evaluations of successful prevention and control interventions require replicating in other countries to test the generalisability of findings across different social, cultural and geographic contexts.
- More evidence is needed from a wider range of countries, in particular resource-constrained settings with less well developed infrastructure.
- To improve generalisability, more comprehensive descriptions of the community engagement strategies and activities used, and information on the acceptability and uptake of the program by different sectors of the community would be useful.
- There is a need for translational research to look at how findings from successful interventions can be translated into effective practice.

Rabies

- Long term evaluations of established rabies surveillance systems are needed that report both process and outcome measures. Researchers should investigate novel methods for passive surveillance for this disease and investigate linking data from veterinary and public health sources.

- There is a need for more evaluation of alternative prevention and control activities, such as canine sterilisation. Outcomes should include measures of human and canine disease, cost and sustainability as well as process indicators such as uptake.
- The use of education and awareness programs should be evaluated to investigate whether they are able to improve uptake of canine intervention strategies.

Nipah virus

- Research should try to identify a suitable animal sentinel for Nipah virus that could be placed under surveillance, as well as identifying animal reservoirs and factors that increase the likelihood of host-animal transmission that could be targeted by control programs.
- There is a need for evaluations of educational programs for farming communities. Studies should report data on process outcomes such as farm management practices and human disease outcomes, as well as rates of disease in pigs.

Dengue

- Evaluations that compare different methods of dengue prevention and control are required. This will allow identification of the independent contribution of specific components of the program to overall effectiveness and identify the most effective strategies. Evaluations should also include measures of cost and sustainability to allow identification of the most efficient long term interventions to reduce the incidence of dengue.
- Evaluations need longer follow-up periods to control for seasonality and the epidemic pattern of disease. They should also provide data on the cost and sustainability of programs.
- Evaluations should report data on dengue incidence and dengue mortality rather than relying on vector indices or process measures for the intervention such as KAP scores or percentage uptake. Further investigation of the correlation (if any) between vector indices (particularly larval indices) and dengue incidence would be useful.
- Researchers should provide more comprehensive descriptions of the community engagement strategies and activities used, and information on the acceptability and uptake of the program by different sectors of the community.
- A description of the role of the research team in projects under evaluation would also be useful to understand how this might impact the success of interventions offered via routine dengue programs rather than in a research environment.

SARS

- A wider range of interventions aiming to prevent or control spread of viral respiratory illness needs to be studied, including the effectiveness of masks and other personal protective equipment, hygiene promotion and disease awareness campaigns, in both close patient contacts and the wider community.

Avian Influenza

- Evaluations of veterinary surveillance systems for avian influenza should look for any evidence of correlation with incidence of influenza in human populations.

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Conflict of interest

No financial conflicts of interest to disclose.

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Appendix I – Search strategy

Only journal articles and reviews dating from January 1980 to December 2011 and published in the English language were considered for inclusion in the review. The following databases were searched: PubMed and CINAHL (via EBSCoHost), ProQuest, Web of Science, ScienceDirect and the Cochrane database of systematic reviews. Only studies that met the inclusion criteria of randomised controlled trials, controlled before-after trials or interrupted time series were evaluated [22].

A two step search strategy was utilised in these databases, as specified below.

- Primary search strategy: Country of interest + Disease of interest + the terms: “surveillance”, “prevention and control”, and “outbreaks”.
- Secondary search strategy: Disease of interest + Search terms: “surveillance” OR “prevention and control” OR “outbreaks” + Search terms: “community” OR “intervention” or “effectiveness” OR “education”. In addition, two more search terms were included that were disease-specific (Table 8).

Table 8: Disease-specific search terms included in the secondary search strategy

Disease	Search terms
Rabies	Infected animals Dog vaccination
Nipah virus	Bats Transmission
Dengue	Mosquito control Vector control
SARS	Quarantine Contact tracing
Avian influenza	Quarantine Infected animals

These search terms were selected on the basis of preliminary searches to determine the most commonly used intervention keywords or subject headings.

Searches based only on the disease of interest were undertaken of the following databases: the WHO library database (WHOLIS), British Development Library, LILACS, World Bank (East Asia) and the Asian Development Bank.

Finally, we examined the reference list of all shortlisted reports, existing systematic reviews and included articles for additional relevant studies.

Appendix II – Critical appraisal instruments

JBI Critical Appraisal Checklist for Systematic Reviews

Reviewer ____________________ Date __________

Author ______________________ Year __________ Record Number ______

	Yes	No	Unclear
1. Is the review question clearly and explicitly stated?	☐	☐	☐
2. Was the search strategy appropriate?	☐	☐	☐
3. Were the sources of studies adequate?	☐	☐	☐
4. Were the inclusion criteria appropriate for the review question?	☐	☐	☐
5. Were the criteria for appraising studies appropriate?	☐	☐	☐
6. Was critical appraisal conducted by two or more reviewers independently?	☐	☐	☐
7. Were there methods used to minimise error in data extraction?	☐	☐	☐
8. Were the methods used to combine studies appropriate?	☐	☐	☐
9. Were the recommendations supported by the reported data?	☐	☐	☐
10. Were the specific directives for new research appropriate?	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reasons for exclusion)

JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial

Reviewer _ Date _

Author _ Year _ _ _ _ _ _ _ Record Number _ _ _ _ _ _ _

	Yes	No	Unclear	Not Applicable
1. Was the assignment to treatment groups truly random?	☐	☐	☐	☐
2. Were participants blinded to treatment allocation?	☐	☐	☐	☐
3. Was allocation to treatment groups concealed from the allocator?	☐	☐	☐	☐
4. Were the outcomes of people who withdrew described and included in the analysis?	☐	☐	☐	☐
5. Were those assessing outcomes blind to the treatment allocation?	☐	☐	☐	☐
6. Were the control and treatment groups comparable at entry?	☐	☐	☐	☐
7. Were groups treated identically other than for the named interventions	☐	☐	☐	☐
8. Were outcomes measured in the same way for all groups?	☐	☐	☐	☐
9. Were outcomes measured in a reliable way?	☐	☐	☐	☐
10. Was appropriate statistical analysis used?	☐	☐	☐	☐
	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reason for exclusion)

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JBI Critical Appraisal Checklist for Comparable Cohort/ Case Control

Reviewer _ Date _

Author _ Year _ _ _ _ _ _ _ Record Number _ _ _ _ _ _ _

	Yes	No	Unclear	Not Applicable
1. Is sample representative of patients in the population as a whole?	☐	☐	☐	☐
2. Are the patients at a similar point in the course of their condition/illness?	☐	☐	☐	☐
3. Has bias been minimised in relation to selection of cases and of controls?	☐	☐	☐	☐
4. Are confounding factors identified and strategies to deal with them stated?	☐	☐	☐	☐
5. Are outcomes assessed using objective criteria?	☐	☐	☐	☐
6. Was follow up carried out over a sufficient time period?	☐	☐	☐	☐
7. Were the outcomes of people who withdrew described and included in the analysis?	☐	☐	☐	☐
8. Were outcomes measured in a reliable way?	☐	☐	☐	☐
9. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reason for exclusion)

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JBI Critical Appraisal Checklist for Descriptive / Case Series

Reviewer _ Date _

Author _ Year _ _ _ _ _ _ _ Record Number _ _ _ _ _ _ _

	Yes	No	Unclear	Not Applicable
1. Was study based on a random or pseudo-random sample?	☐	☐	☐	☐
2. Were the criteria for inclusion in the sample clearly defined?	☐	☐	☐	☐
3. Were confounding factors identified and strategies to deal with them stated?	☐	☐	☐	☐
4. Were outcomes assessed using objective criteria?	☐	☐	☐	☐
5. If comparisons are being made, was there sufficient descriptions of the groups?	☐	☐	☐	☐
6. Was follow up carried out over a sufficient time period?	☐	☐	☐	☐
7. Were the outcomes of people who withdrew described and included in the analysis?	☐	☐	☐	☐
8. Were outcomes measured in a reliable way?	☐	☐	☐	☐
9. Was appropriate statistical analysis used?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

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JBI Critical Appraisal Checklist for Economic Evaluations

Reviewer ________________________ Date ________________________

Author __________________________ Year_______ Record Number ______

	Yes	No	Unclear	Not Applicable
1. Is there a well defined question?	☐	☐	☐	☐
2. Is there comprehensive description of alternatives?	☐	☐	☐	☐
3. Are all important and relevant costs and outcomes for each alternative identified?	☐	☐	☐	☐
4. Has clinical effectiveness been established?	☐	☐	☐	☐
5. Are costs and outcomes measured accurately?	☐	☐	☐	☐
6. Are costs and outcomes valued credibly?	☐	☐	☐	☐
7. Are costs and outcomes adjusted for differential timing?	☐	☐	☐	☐
8. Is there an incremental analysis of costs and consequences?	☐	☐	☐	☐
9. Were sensitivity analyses conducted to investigate uncertainty in estimates of cost or consequences?	☐	☐	☐	☐
10. Do study results include all issues of concern to users?	☐	☐	☐	☐
11. Are the results generalisable to the setting of interest in the review?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reasons for exclusion)

Appendix III – Data extraction instrument

DATA EXTRACTION TABLE	
Reviewer & date	
Publication details (Author, year)	
STUDY DETAILS	
Country setting	
Urban/rural context	
Study design	
Prospective/retrospective data collection	
Length of follow up (with dates)	
Community groups involved	
Sample size (individuals, households and communities)	
Authors main research question	
Process/output indicators used for evaluation (e.g. proportion of population covered, participant knowledge & attitude scores, vector indices)	
Infection/disease outcomes used for evaluation (e.g. incidence rates, prevalence rates, number of outbreaks)	
Cost/sustainability indicators used for evaluation	
INTERVENTION	
Surveillance or prevention/control	
Infectious disease(s) targeted	
Broad type(s) of intervention used	
Core elements of the intervention	
Behavioural mechanisms or program theory identified by the authors	
Outbreak response/ongoing?	

Funding for intervention	
Groups involved in program delivery	
OUTCOMES	
Process/output results Control group or before results (list all reported)	
Process/output results Intervention group or after results (list all reported)	
Infection/disease results Control group or before results (list all reported)	
Infection/disease results Intervention group or after results (list all reported)	
Cost/sustainability results Control group or before results (list all reported)	
Cost/sustainability results Intervention group or after results (list all reported)	
Authors main conclusions	
KEY LIMITATIONS & LEVEL EVIDENCE (as identified by reviewer based on JBI instruments)	
CONTEXTUAL FACTORS	
Study context (list all reported) (e.g. climatic factors, economic context, existing health, veterinary and environmental infrastructure)	
Behavioural mechanisms (list all reported) (e.g. perceptions about disease, cultural and social norms and attitudes, relationship to community economic activities)	
Program structure & delivery (list all reported) (e.g. role of research team, agencies involved in delivery, resourcing for program, interaction with other agencies)	

Appendix IV – Characteristics of included studies

Table 9: Rabies - Study characteristics of included studies

Reference	Study characteristics					
	Setting	**Design, study type**	**Length of observation**	**Study population**	**Sample size**	**Research question**
Estrada, 2001[50]	Coastal village of Mindoro, La Union, Philippines	Cohort for most part, 10% before/after	29 days post intervention	All owned dogs > 2 months old	175 dogs; 14 dogs tested for seroconversion	Role of oral vaccination of dogs into national rabies program in Philippines
Kamoltham, 2003[54]	Phetchabun Province, north-central Thailand	Cohort (dogs), time series data; Case series (human cases)	Canine vaccination 1997-2001 (6 years); Human exposures and deaths 1992-2001 (10 years)	Exposed persons receiving PEP* in Phetchabun province; dog population in Phetchabun	10,350 persons receiving PEP*; 587, 528 dogs eligible for vaccination	Elimination of rabies throughout the province by 2000 through various strategies
Robinson, 1996[67]	Urban and rural areas, Sorsogon Province, Philippines	Prospective cohort	Two months, April and May 1993	Owned dogs > 1 month old, not previously vaccinated and healthy	297 dogs; 210 households; 1131 persons	Evaluation of vaccination campaign as a pilot study for a rabies elimination program
Soon, 1988[68]	Peninsular Malaysia	Case series (animals), retrospective outbreak analysis	41 years: 1946-1987	laboratory confirmed cases of rabies in animals	1002 animals	Control of rabies epidemic in Peninsular Malaysia in 1952; post-outbreak control program
Windiyaningsih, 2004[81]	Flores Island and other districts of Nusa Tenganara province, Indonesia	Pre- and post-cohort intervention (dogs); case series (human cases)	Five years: 1998-2002	Cases of human rabies on Flores Island; dogs on Flores and other districts of Nusa Tenganara province	58, 980 dogs vaccinated 2000-02; 295, 569 dogs culled 1998-2001	Control of rabies epidemic on Flores and other islands; post-outbreak control measures

*Abbreviations: PEP – post-exposure prophylaxis

Table 10: Rabies - Details of interventions and outcomes evaluated in included studies

Type of intervention				
Reference	**Type of intervention**	**Description of intervention**	**Type of outcome measure**	
	Categorise into broad groups		**Process/output Indicators**	**Infection outcomes**
Estrada, 2001[50]	Vaccination	House-to-house survey followed by mass canine vaccination using oral baits; eight vaccination teams consisting of two persons each	Vaccination coverage: Percentage of baits accepted over total offered; percentage of dogs seroconverted from small sample (10%) who had accepted bait.	None
Kamoltham, 2003[54]	Vaccination (canine and human); Education; Canine sterilisation; PEP for exposed persons	Canine vaccination and sterilisation; educational awareness of rabies – advocacy in schools, TV programs, newspapers; education of medical officials and local residents; increased uptake of PEP* for exposed persons	Proportion of dogs vaccinated	Annual number of human rabies deaths in Phetchabun Province
Robinson, 1996[67]	Vaccination; education	Vaccination of owned dog population: vaccination teams visited 30 selected villages; survey teams revisited the villages to assess vaccine coverage. Vaccinated dogs identified by sighting vaccination certificates or examining special collar or paint mark; two household surveys; educational prompts (posters, public broadcasts)	Vaccination coverage; participation rate of households	None
Soon, 1988[68]	Multiple: vaccination; education, movement restriction; quarantine	Canine vaccination; maintenance of "immune belt" Thai/Malay border; regulation of importation of dogs; quarantine of newly arrived dogs; compulsory licensing of dogs; public education through mass media	None	Number of cases of confirmed rabies in animals (mostly dogs) in Malaysia
Windiyaningsih, 2004[81]	Culling; Vaccination (animals and humans)	Mass culling of dog population; canine vaccination campaign	Percentage of dogs killed, percentage of dogs vaccinated, percentage of dogs rabies positive	Number of human rabies deaths

*Abbreviations: PEP – post-exposure prophylaxis

Table 11: Rabies - Main findings and limitations of included studies

Main findings				
Reference	**Intervention group**	**Control group**	**Author's findings**	**Main limitations**
Estrada, 2001[50]	Overall vaccination rate 76% (133/175); 86% (12/14) dogs seroconverted based on sample	None	bait delivery system is cheap, safe, effective, cost-beneficial	Only small sample (10.5%) of dogs measured for seroconversion
Kamoltham, 2003[54]	417, 147/ 587, 528 dogs vaccinated (71%) over six years (1996 – 2001); 10,350 patients received PEP* over six years (1997 – 2001); Number of deaths decreased from three in 1992 to none in 2001.	None	Program successful because no human deaths reported in last three years of program	No before/after KAP* surveys around educational campaign; Number of human rabies deaths before/after canine vaccination small, also confounded by increasing administration of PEP* of animal bites to humans
Robinson, 1996[67]	178/243 (73%) (61.8, 83.1) of eligible dogs vaccinated; 82% of vaccinated dogs marked with collar or paint; 105/142 (74%) of households participated. Dogs more likely to be vaccinated if restrained (during the day OR*=9.97, p=0.006, at night OR=9.03, p=0.01), if kept as guards (OR=2.56, p=0.016) or if household received campaign information from more than one source (OR=4.45, p=0.04). Dogs less likely to be vaccinated if kept for food (OR=0.32, p=0.006) or if household had learned of campaign primarily through posters (OR=0.30, 0.015) Confidence intervals were not provided for any of the estimates of risk.	None	Vaccination coverage sufficiently high to potentially control rabies transmission among dogs	Low quality study, only one time point. No assessment of effectiveness of intervention; 18% of vaccinated dogs had not been marked, one unvaccinated dog had collar; in two barangays number of vaccinated dogs exceeded estimated dog population
Soon, 1988[68]	No rabies positive animals in 1986-87	218 cases in 1952 at peak of outbreak	rabies well controlled after implementation of National Rabies Control Program 1955-present	No denominator data for main outcome data (presents number of cases before and after intervention)
Windiyaningsih, 2004[81]	Total dog population in six districts of Flores in 2002 127,482 dogs (80% reduction); Culling: 295, 569 dogs culled from 1998-2001;	Total dog population in 1998 in six districts of Flores: 617,551 dogs Number of human deaths from rabies 8	Program not successful because of importation of diseased dogs, movement of diseased dogs off island, failure of citizens to cull	Missing information on culling and dogs vaccinated for some regions (drop in dog population and number of dogs culled does

	Vaccination: 58,980 dogs vaccinated in total from 2000 – 2002 (46% of 2002 population); 3143/3917 (80%) dogs examined over four years (1998-2001) were laboratory positive for rabies Number of human deaths from rabies 10 in 1998, 26 in 1999, 58 in 2000, 11 in 2001	in 2002	diseased dogs, inadequate vaccination	not match up); Intervention confounded by persons receiving PEP* for animal bites

*Abbreviations: KAP: Knowledge, Attitudes and Practices; OR: odds ratio; PEP: post-exposure prophylaxis

Table 12: Rabies - Contextual information extracted from included studies

Reference	Qualitative information		
	Contextual factors	**Behavioural mechanisms**	**Program details**
Estrada, 2001[50]	Mindoro rabies free since 1995; advantage of cheap local materials for baits; loss of interest following cyclone that hit the island	reluctance of owners to have dogs repeatedly bled; demands for financial compensation for dogs handed over for rabies diagnosis	Eight vaccination teams of two persons each; vaccine provided by IDT GmBH; students at DMMMSU, IDT GmbH, FRC Germany for evaluation of blood samples
Kamoltham, 2003[54]	Rabies endemic in Thailand; Decentralisation of public health system in 2001 resulted in underreporting by provinces (not all provinces reporting nationally) Expansion of the Thai Red Cross intradermal regimen with the advent of purified vero cell rabies vaccine	None mentioned	Ministries of Public Health (Office of Public Health, Phetchabun), Agriculture (Phetchabun Livestock Department) and Education; volunteers travelling to various sites to offer free canine vaccination
Robinson, 1996[67]	Rabies endemic in the Philippines; Pre-campaign education and advertisements contributed to success of program: "high percentage of homeowners were home and willing to participate"	Refusal to participate for various reasons (owner not wanting to cause injury to dog from vaccination, some dogs for consumption and perception that vaccine altered meat, lack of knowledge about campaign). One barangay (village) selected for inclusion required substitution because of civil unrest	veterinarians and veterinary students, Department of Health sanitarians, Dept of Agriculture animal technicians, community volunteers; house-to-house vaccination teams
Soon, 1988[68]	None mentioned	None mentioned	Government departments (Department of Veterinary Service of the Ministry of Agriculture, Ministry of Health)
Windiyaningsih, 2004[81]	Prior to 1998 Flores Island rabies-free; Climate of social instability, currency devaluation and decentralisation of administrative power at the time meant that district authorities acted independently.	Reluctance by members of the public to kill dogs perpetuated outbreak; some dogs moved to rabies-free districts or sold at markets to avoid killing; practice of fishermen to travel with their dogs and subsequently visit other islands aided spread of outbreak	locally hired men or citizens to carry out killing; vaccine provided by Italy; WHO, Queen Saovabha Institute, Thailand, district health centres; consultation with religious, political and health care leaders and the public

Table 13: Nipah virus - Study characteristics of included studies

Reference	Study characteristics					
	Setting	Design, study type	Length of observation	Study population	Sample size	Research question
Arjoso, 2001[25]	Indonesia	Retrospective analysis of outbreak case series (humans & animals)	2 months: April/May 1999	Pig and human populations from North Sumatra, East Sumatra and Riau Islands	373 female pig breeders; 360 pigs from overall population; 137 pig farmers and abattoir workers	Active surveillance of Nipah virus infection in Indonesia following the Malaysian outbreak
Arshad, 2001[26]	Peninsular Malaysia	Retrospective analysis of outbreak case series (animals)	Oct 99 – Mar 00 in pig abattoirs; Apr – Dec 00 in pig farms	Confirmed swine cases of Nipah virus infection in pig abattoirs and farms	20 pig sera from 6 abattoirs; 7,576 sera from 414 farms	Phase III of the National Swine Surveillance Program
Bunning, 2001[29]	Peninsular Malaysia	Retrospective analysis of outbreak case series (humans)	11 months (October 98 – September 99)	Confirmed human cases of Nipah virus infection	208 human cases	To describe the Nipah virus outbreak in Malaysia in 1999
CDC, 1999[30]	Singapore and peninsular Malaysia	Retrospective analysis of outbreak case series (humans)	6 months (Oct 1998-apr 1999) in Malaysia; 1 week in Singapore	Human cases of Nipah virus infection	257 cases in Malaysia, 11 cases in Singapore	To describe the Nipah virus outbreak in Malaysia and Singapore in 1999
Mohd Nor, 2000[36]	Peninsular Malaysia	Retrospective analysis of outbreak case series (animals)	3 months (21 Apr – 20 July)	Swine population in abattoirs and on farms	889 farms; total number of pigs not stated; total culled 172,750	Describes the National Swine Surveillance Program
Muniandy, 2004[37]	Peninsular Malaysia	Retrospective analysis of outbreak case series (animals)	3 months (21 Apr – 20 July)	Swine population in abattoirs and on farms	36,125 blood samples from 879 farms and 8 abattoirs; 5587 samples from abattoirs managed by DVS*; 946 pig farms in all Malaysia Phase III (45, 874 sera)	Describe the national swine surveillance program
Ozawa, 2001[40]	Peninsular Malaysia	Retrospective analysis of outbreak case series (animals)	3 months (21 April – 20 July)	Swine population in abattoirs and on farms	896 farms (27,620 serum samples); further 5,487 serum samples from government abattoirs	Describes National Swine Surveillance Program post-outbreak

*Abbreviations: DVS: Department of Veterinary Services, Malaysia

Table 14: Nipah virus - Details of interventions and outcomes evaluated in included studies

Type of intervention				
Reference	**Type of intervention**	**Description of intervention**	**Type of outcome measure**	
	Categorise into broad groups		**Process/output Indicators**	**Infection outcomes**
Arjoso, 2001[25]	Surveillance	Screening in North Sumatra (live pigs and pig handlers), city markets (live fruit bats) and abattoirs (slaughtered pigs and workers); East Sumatra (live pigs and pig handlers); Riau Islands (live pigs and pig handlers), with culling of any positive pigs	Number of swine cases of Nipah virus infection (swine surveillance)	Number of laboratory confirmed human cases of Nipah virus infection
Arshad, 2001[26]	Surveillance	Sero-surveillance of pigs in government abattoirs and on farms; trace back through farm-specific ear tags and depopulation of the farm if any positive pigs. At least 30 samples per farm.	Number of cases of Nipah virus infection in swine	None
Bunning, 2001[29]	Multiple: Source reduction; Movement restriction; Surveillance	Three phase control program. Phase I included complete halt of movement of livestock in the country for two weeks and depopulation of all infected farms; Phase II: Swine herds on farms with confirmed human or swine case tested serologically, then, within 90 days, at least 15 pigs on every swine herd tested serologically. Phase III: Active surveillance in slaughterhouses with random testing.	Number of swine cases of Nipah virus infection (swine surveillance)	Number of laboratory confirmed human cases of Nipah virus infection
CDC, 1999[30]	Multiple: Culling; restriction of movement of animals; Education; Surveillance	Mass depopulation of pigs in Perak, Negri Sembilan and Selangor states of Malaysia; ban on transporting pigs within the country; closure of abattoirs and cessation of pig importation from Malaysia into Singapore; education about handling pigs, uses of PPE*; national surveillance and control system to detect and cull additional infected herds	None	Number of human cases of Nipah virus infection

Mohd Nor, 2000[36]	Surveillance; culling; Education	Phase I: eradication policy by mass culling of diseased and in-contact pigs (Feb – Apr 99); Phase II and Phase III: National Swine Surveillance Program. Phase II: surveillance of farms and abattoirs (21 Apr – 20 Jul 99, 90 days) to detect any infected farms outside of containment areas. Each farm sampled twice, at least 3 weeks apart. Minimum number of sows calculated at 15/farm. If 3 or more sera positive farm designated for culling. Phase III: control program being developed to monitor all pigs entering abattoir, including ear notching system to identify pigs from all the coded farms and allow trace back followed by culling; Education of farmers (identification of disease, personal safety practices, disinfection)	Number of Nipah virus positive swine blood samples	None
Muniandy, 2004[37]	Surveillance; culling	Phase I: eradication policy by mass culling of diseased and in-contact pigs (Feb – Apr 99); Phase II and Phase III: National Swine Surveillance Program. Phase II: surveillance of farms and abattoirs (launched 21 Apr 99) to detect any infected farms outside of containment areas. Each farm sampled twice, at least 3 weeks apart. Minimum number of sows calculated at 15/farm. Phase III: control program being developed to monitor all pigs entering abattoir, including ear notching system to identify pigs from all the coded farms and allow trace back followed by culling;	No. of Nipah virus positive swine blood samples	None
Ozawa, 2001[40]	Surveillance; culling	Phase I: eradication policy by mass culling of diseased and in-contact pigs (Feb – Mar	Number of Nipah virus positive swine blood samples	None

		99); Phase II and Phase III: National Swine Surveillance Program. Phase II: surveillance of farms and abattoirs (Apr – July 99) to detect any infected farms outside of containment areas. Serological sampling of statistically significant number of sows performed twice, at least 3 weeks apart. GPS readings allowed trace back of farms. Random sampling also of slaughtered pigs in 6 government and 2 private abattoirs implemented in Apr 2000. Phase III: surveillance of farms and abattoirs followed by depopulation of positive farms (Mar 00). Ear notching system also implemented.		

*Abbreviations: PPE: personal protective equipment; GPS: global positioning satellite

Table 15: Nipah virus - Main findings and limitations of included studies

Main findings			
Reference	**Intervention measure**	**Author's findings**	**Main limitations**
Arjoso, 2001[25]	No evidence of Nipah virus from 372 pigs, 5 bats, 138 adult humans.	Absence of Nipah virus in areas closest to Malaysian epidemic indicates that public health interventions put in place by Malaysian and Singaporean governments effective in controlling cross-border spread.	Limited information on sampling strategy ("surveyed farms selected on the basis of close proximity to Malaysian peninsula")
Arshad, 2001[26]	Abattoir surveillance: 67/7576 sera (0.88%) from 414 farms positive by ELISA but not by SNT test. Farm surveillance: 757/810 (93%) and 710/810 (88%) of farms screened in first and second round. 442/21,276 (2%) positive in first screening; 538/19,098 (3%) positive in second round; 193/810 (27%) of farms had at least one positive serum by ELISA; only 28/958 (2.9%) positive sera were also positive by SNT test. The SNT positive pigs were destroyed.	Surveillance program successful. Malaysia achieved Nipah virus free status without vaccination	Only 51% of farms sampled.
Bunning, 2001[29]	Outbreak peaked in March 1999 with nine cases/week. Phase I initiated late March 1999 to April 1999, Phase II from mid-April 1999 to late May 1999. No new cases detected after May 1999. In total, mandated destruction of more than 1.1 million pigs National Control and Surveillance Program rapidly developed and implemented	Spread of outbreak directly related to movement of pigs between farms. Outbreak ceased after culling of pigs, suggesting infected pigs required to sustain transmission.	No denominator data for main outcome data; no historical controls; no data on sero-surveillance
CDC, 1999[30]	890,000 pigs killed to date; Malaysia: peak of 46 new cases in 13-19 March to 4 cases during 10-16 April Singapore: No new cases post outbreak control measures (cessation of pig importation, closure of abattoirs)	Absence of new cases in Singapore following closure of abattoirs and decrease in cases in Malaysia following institution of outbreak control measures suggest contact with infected pigs source of outbreak	No denominator data for main outcome data; no historical controls. Does not give information on when interventions were carried out in relation to progression of outbreak.
Mohd Nor, 2000[36]	Phase I: 901,228 pigs from 896 farms destroyed in infected areas from 28 Feb – 26 Apr 99. Phase II: 50/889 (5.6%) farms screened found to be positive; 172,750 pigs slaughtered from these farms. No new cases of Nipah virus in humans	Screening of sow blood allowed detection of infected farms	No information on total sample size; most private abattoirs not included in the surveillance program

	or pigs since surveillance program completed		
Muniandy, 2004[37]	50/879 (5.6%) positive; 172, 750 pigs slaughtered; 91/10,982 (0.8%) positive from abattoir surveillance; 30/45,874 (0.065%) sera from two farms positive. All pigs culled	Screening of sow blood allowed detection of infected farms	No information on total sample size; most private abattoirs not included in the surveillance program
Ozawa, 2001[40]	Phase II: total of 50/896 (5.6%) farms positive (total serum samples 27,620); another high risk farm identified through trace back of positive samples taken from abattoirs (total 5,487 samples); Phase III: 500 of the 796 farms covered by government abattoirs included in the surveillance program. Two farms (0.25%) positive	No new cases of Nipah virus infection in humans or pigs since the end of May 1999 following surveillance and depopulation measures. Most countries in Asia need to strengthen traceability mechanisms to determine origin of pathogens causing new epidemics.	No information on total sample size; most private abattoirs not included in the surveillance program (not stated how many)

*Abbreviations: ELISA: enzyme-linked immunosorbent assay; SNT: serum neutralisation test

Table 16: Nipah virus - Contextual information extracted from included studies

Reference	Qualitative information		
	Contextual factors	Behavioural mechanisms	Program details
Arjoso, 2001[25]	Restrictions on pork products and live pig exportation from Indonesia were enacted by governments of Thailand, Singapore and the Philippines in the absence of reliable surveillance data pertaining to Nipah virus in Indonesia. Surveillance initiative necessary to protect economic integrity of swine industry	None reported	Indonesian Ministry of Health, in cooperation with Ministry of Agriculture and Livestock. Informed consent from pig farmers and abattoir workers.
Arshad, 2001[26]	None stated	None reported	Malaysian government (Department Veterinary Services, Veterinary research Inst., Dept. Medical Microbiology, University Malaya, CDC, Australian Animal Health laboratory and Animal Research Institute, local health practitioners. Initially culling carried out by farmers and later by the military.
Bunning, 2001[29]	Eradication of 1.1 million swine represented about 40% of the swine population in Malaysia in 1999. 800 of 1700 swine operations put out of business as a result of depopulation efforts Illness believed to be Japanese encephalitis (JE) at first. Malaysian government invested heavily in vaccinating farmers against JE	None reported	Malaysian government (Department of Veterinary Services), Veterinary Research Institute, Department of Medical Microbiology, University of Malaya, CDC, Australian Animal Health laboratory and Animal Research Institute, local health practitioners. Initially culling carried out by farmers and later by the military.
CDC, 1999[30]	Fire sale of sick pigs from one farm in Perak responsible for initial spread of outbreak	None reported	Malaysian govt (Dept Veterinary Services, Veterinary research Inst., Dept. Medical Microbiology, University Malaya, CDC, Australian Animal Health laboratory and Animal Research Institute, local health practitioners. Initially culling carried out by farmers and later by the military.
Mohd Nor, 2000[36]	Number of farms reduced from 1885 to 829. Outbreak caused dramatic change in pig farming industry. Pig farming only allowed now in pig farming areas designated by Ministry of Agriculture.	None reported	Malaysian govt (Dept Veterinary Services, Veterinary research Inst., Dept. Medical Microbiology, University Malaya, CDC, Australian Animal Health laboratory and Animal Research Institute, local health practitioners. Initially culling carried out by farmers and later by the military.
Muniandy, 2004[37]	Presumed 'index case' in 1997 came from a pig farm in a district interspersed among orchards with a wide variety of fruit crops. Limestone caves near farms	None reported	Malaysian govt (Dept Veterinary Services, Veterinary research Inst., Dept. Medical Microbiology, University Malaya, CDC, Australian Animal Health laboratory and

	formed roosting grounds for fruit bats. Pig farms had fruit trees around pig pens. Speculation that bat excretions have entered pens. Authors have postulated that intensification of traditional farming system has contributed to environments that enhance transmission of diseases from wildlife reservoirs. New guidelines proposed by DVS to restructure the industry. Old practice of sharing boars or moving sows from farm to farm Annual export market to Singapore and Hong Kong at US$120 million was lost. Total estimated cost US$500 million		Animal Research Institute, local health practitioners. Initially culling carried out by farmers and later by the military.
Ozawa, 2001[40]	Active trading between pig farms normal practice in Peninsular Malaysia.	Farm codes tattooed on the back of animals stamped by butchers themselves. Difficulties encountered by the trace back system in abattoir surveillance pointed to irregularities with the tattooing system. Ear notching later introduced to circumvent fraud	Malaysian government (Dept Veterinary Services, Veterinary research Institute, Dept. Medical Microbiology, University Malaya, CDC, the Australian Animal Health laboratory and Animal Research Institute, local health practitioners. Initially culling carried out by farmers and later by the military.

Table 17: Dengue - Study characteristics of included studies

Reference	Study characteristics					
	Setting	**Design, study type**	**Length of observation**	**Study population (intervention and control groups)**	**Sample size**	**Research question**
SURVEILLANCE						
Barbazan, 2002[28]	Whole of Thailand at province level	Observational; retrospective case series	monthly surveillance data; 1983 - 1995	73 provinces	National population figures over 12 years	Undertake spatial and temporal analysis of routine surveillance data to determine potential for use as a predictive tool for epidemic/outbreak warning
Chairulfatah, 2001[31]	Bandung, Indonesia	Case series, retrospective	8 months: Apr 94-Mar 95	Hospitalised patients of suspected DHF/DSS at four hospitals; cases reported to local PHU	650 patients	Evaluate the adequacy, accuracy and reporting delay of DHF case reporting system
Chan, 2011[32]	Indonesia and Singapore	Model-based using time series data, retrospective	2003-2007	Whole country	Not stated	Assess whether web search queries are a viable data source for the early detection and monitoring of dengue epidemics
Osaka, 1999[38]	Dong Nai Province, Southern Viet Nam	Two group comparison	10 months: Feb – Dec 1997	Two communes: Binh Minh commune (study area) and Trang Bom commune (control area)	Study area: population 13,550, 2408 households; Control area: population 11,274, 2,342 households	Evaluate the feasibility and effectiveness of active surveillance of dengue patients (note that evaluation of use of insecticidal aerosol cans discussed separately under prevention & control)
Oum, 2005[39]	Seven rural communes in Cambodia	Cohort, prospective	Two years: Sep 2000-Aug 2002	Communes located in four provinces, among those in Border Malaria Control Project funded by European Commission	52 villages, total population 30,000 in year 2000	Assess performance of a community-based surveillance system (CBSS) to provide timely and representative information on major health problems and rapid and effective control of outbreaks
Pang, 1989[41]	Kuala Lumpur area, Malaysia	Prospective case series	30 month period	Patients from two private GP clinics	610 patients suspected of dengue fever	Pilot of a sentinel surveillance system to establish a more practical diagnostic approach to

						produce a more accurate epidemiological profile of prevalence and transmission (therefore more effective surveillance)
PREVENTION/CONTROL						
Ang 2007[44]	Singapore (urban)	Comparable cohort intervention study, prospective	17 Sep – 22 Oct 2005	All 84 electoral constituencies	888, 000 homes	Evaluation of outdoor "carpet combing" and indoor "10 min mozzie wipe-out" source reduction and clean up exercises as promising control strategies against dengue in Singapore
Beckett, 2004[45]	Bandung, Java, Indonesia (urban)	Observational; prospective cohort	18 months between test & re-test	2,340 participants completed both pre-test and post-test	2,340 participants	Evaluation of educational program directed at textile workers
Butraporn, 1999[47]	Ban Non village, Tambon Non Samran, Muang district, Chaiyapum province, Thailand (rural)	Observational; prospective comparative cohort	December 1998 to January 2000, implemented for 'one year', difficult to work out when study started	1 intervention (Ban Non) and 1 control village	Unclear. Ban Non 392 households, population 1163. Does not detail control village. KAP survey done on 203 heads of population. Does not say how many surveyed for larval indices	Evaluation of educational (awareness) and environmental management
Crabtree, 2001[48]	Sarawak, Malaysia (rural)	Control and intervention areas, before and after follow-up, prospective	Unclear; March 1998-November 1998	Semi-rural coastal villages	3 coastal villages (two intervention, one control). 65 households surveyed in Beradek, 115 in Semilang and 24 in Sg. Aur (control)	Reduce a high Aedes mosquito index and associated risk of dengue using behaviour modification strategies through a community participatory approach
Eamchan, 1989[49]	Northeast Thailand (rural)	Before/after in treatment area only; prospective	One month: 13 August – 15 September 1987	Village 4 in Khokarachai subdistrict, Khonburi District, Nakhon Ratchasima Province	52 households before treatment, 49 households after treatment	Assess vector control measures in response to an outbreak of dengue haemorrhagic fever
Hien, 2011[52]	South Viet Nam (rural)	Comparable cohort intervention study, prospective	18 months: July 2008 – October 2009	Households in Can Giuoc district, Long An province	50 households intervention and control each	Acceptability and use of new mosquito-proof tank containers and plastic covers for existing containers
Igarashi, 1997[53]	Cam Binh district, North	Observational;	March 1994 - Dec 1994	500 households control,	1,000 households	Evaluation of Olyset net

	Viet Nam (urban + rural)	prospective comparative cohort	(10 months)	500 intervention		(impregnated netting) for use in vector control and dengue prevention
Kay, 2002[56]	Northern Viet Nam (urban + rural)	Intervention and control areas, prospective	April 1998-March 2000 (3 month follow-up intervals)	Rural (8 communes) and urban (2 communes)	6 intervention communes, 11,675 households, 49,647 people (5 rural, 1 urban) with four communes as controls (3 rural, 1 urban)	Evaluate effectiveness of community based Mesocyclops program in eradicating Ae. aegypti
Kay, 2005[55]	North and Central Viet Nam (urban + rural)	Intervention and control areas, prospective	1998-2003	Rural and urban communes	37 northern communes in three provinces; 309, 730 people	Evaluate effectiveness of community based Mesocyclops program in eradicating Ae. aegypti
Kay, 2010[57]	North and Central Viet Nam (urban + rural)	Intervention and control areas, prospective	2003-2008	Rural and urban communes	2 project communes (program run by authors), 1 semi-project commune (same program but not part original project), 4 national program communes (different program), 1 untreated commune (control)	Evaluate sustainability of community based Mesocyclops program in eradicating Ae. aegypti
Kittayapong, 2008[58]	Chachoengsao province, Thailand (rural)	Before/after in treatment and control areas, prospective	18 months	Rural/semi-rural	1800 students, 151 (?) containers, unknown number mosquito landing surveys	1. Designing dengue control program for rural and semi-rural Thailand; 2. Examining possibility of mapping dengue foci
Madarieta, 1999[59]	Cebu city, The Philippines (urban)	Controlled trial, prospective	Six months (August 1996-May 1997)	2 areas, Barangay Labangon (intervention) and Barangay Mabolo (control)	65 households in each	Assess the use of permethrin-treated curtains for the control of mosquito vectors for dengue
Nam, 1998[62]	North Viet Nam (rural)	Control and intervention areas, before and after follow-up, prospective	Jan 1993-Nov 1996	Two semi-rural villages	1 intervention village and one control village, each 400 houses	Evaluate effectiveness of community-based Mesocyclops program in eradicating Ae. aegypti
Nam, 2005[61]	Central Viet Nam (rural)	Control and intervention areas, prospective	Sep 2000 – Jun 2003	Village volunteers	3 intervention and two control communes. 120 schoolteachers; 159, 206 visits to households	1. To reduce incidence of dengue and DHF by controlling/eliminating A. aegypti; 2. Strengthen capacity of staff to deliver community programs

Osaka, 1999[38]	Dong Nai Province, Southern Viet Nam (urban)	Two group comparison	10 months: Feb – Dec 1997	Two communes: Binh Minh commune (study area) and Trang Bom commune (control area)	Study area: population 13,550, 2408 households; Control area: population 11,274, 2,342 households	Evaluate the feasibility and effectiveness of active surveillance of dengue patients and use of insecticidal aerosol cans
Pengvanich, 2011[64]	Two communities in Mueang Municipality, Chachoengsao Province, Thailand (rural)	Two group pre-, post-test design (comparable cohort), prospective	8 weeks Apr-Jun2010	Family leaders residing in Namueang and Sothorn communities	120 family leaders, 60 in empowerment program, 60 in control group	Assess performance of empowerment program using participatory learning process for control of Dengue vector
Phan-Urai, 1995[65]	Chanthaburi province, Thailand (rural)	Comparable cohort, prospective	April 8 – Nov 12, 1992	Two rural villages, Village 3 and 5 of Tambon Taporn	61 houses intervention village, 92 houses control village	To evaluate the Bti H-14 (Larvitab) tablet for Aedes larvae reduction
Phantumacinda, 2005[66]	3 subdistricts of Phanus Nikhom district, Chonburi Province, Thailand (urban + rural)	Comparable cohort, prospective	3 years, 1982-1985	Phanus Nikhom municipality (urban) and two neighbouring subdistricts, Wat Boat and Wat Luang (rural)	2221 premises (urban), 1224 premises (rural)	Develop mechanisms for people in the p/c of DHF through source reduction
Suaya, 2007[69]	Cambodia (urban)	Retrospective cohort	4 years: 2001 – 2005	Two urban areas of Cambodia: Phnom Penh and Kandal	2.9 million people	To assess the cost-effectiveness of annual targeted larviciding campaigns against Aedes aegypti in two urban areas of Cambodia
Suroso, 1990[70]	Pekalongan, Central Java, Indonesia (rural)	Prospective cohort	6 months between pre-test and post-test July-Dec 1985	4 Health Centres: Kusuma Bangsa, Bendan, Tondano, Nayantaan	133 schools, 266 school children's dwellings, 200 other houses	Control of A. aegypti by source reduction through activities to promote source reduction (following community education)
Suwanbamrung, 2011[71]	Nakhon Sri Thammarat, Southern Thailand (semi-urban)	three cohorts pre-and post-intervention; mixed method research design (qualitative, quantitative)	13 months: Oct 2009 – Oct 2010	Three village communities in Meung district: Ban Mon (320 households), semi-urban village at cross-road community, Ban Nangpraya (344 households), seaside community, semi-urban, Ban Kang (239 households), garden model	Leaders (26, 24, 28) and "non-leaders" (200, 215, 176)	Develop and evaluate a community capacity model which is based on the community context for leader and non-leader groups
Swaddiwudhipong, 1992[72]	Mae Sot District, Tak Province, Thailand	Prospective cohort Study	20 months, March 88-August 90	Urban community	6341 houses, 20,283 inhabitants	Effect of health education and community

	(urban)					participation on a DHF control program
Therawiwat, 2005[74]	Kanchanaburi Province, Thailand (rural)	Comparable cohort	13 months: June 2004 – June 2005	Two villages: Vang Yen (intervention) and Ban Kao (control)	53 key community leaders (32 intervention group, 21 control group) and 234 representatives of household members (100 intervention group, 134 control group)	Assess effectiveness of a community-based program involving education and behavioural change
Tun-Lin, 2009[76]	Eight countries, data extracted on Myanmar (urban), Philippines (urban) & Thailand (urban)	Cluster randomised trial, prospective	Follow-ups at 1 and 5 months	Yangon City, Myanmar; Quezon City, the Philippines; 3 provinces in Thailand including the capital cities Chachoengsao, Chiang Mai and Salsabury (urban)	Philippines: 9 clusters per arm (90-100 household per cluster); Myanmar: 10 clusters per arm (90-100 households per cluster); Thailand 9 clusters per arm (100 households per cluster)Pro	1. Non-inferiority hypothesis: targeted vector control program gives same reduction in vector numbers as non-targeted approach; 2. Is targeted approach cheaper?
Umniyati, 2000[77]	Perumnas Condong Catur, Yogyakarta special province, Indonesia (urban)	Two group pre-post-test design (comparable cohort)	12 weeks: 25 June-4 Sep 1993 (6 weeks in dry and 12 weeks in wet season)	Rukun Wilayah 17 (test area) and 13 (control area)	Unclear. Community participation of 10-15 housewives, but does not say if 10-15 households or more	Evaluate source reduction through community participation of Dasawisma (group of 10-15 housewives)
Vanlerberghe, 2011[79]	Laem Chabang, Chon Buri province, Thailand (urban)	Cohort study	18 months: Mar 07-Oct 08	Households of major port city	2032 households (22 clusters of 80-110 houses) in four town districts	1. Assess the acceptance of insecticide-treated curtains and IT jar covers for dengue control 2. Study their continued use and its determinants

Table 18: Dengue - Details of interventions and outcomes evaluated in included studies

Type of intervention				
Reference	**Type of intervention** (categorised into broad groups)	**Description of intervention**	**Type of outcome measure**	
			Process/output Indicators	**Infection outcomes**
SURVEILLANCE				
Barbazan, 2002[28]	Surveillance	Use of routine surveillance data to test threshold definitions of epidemic activity and predict epidemics	Predictive ability, outbreak/epidemic warning (yes/no) by month & region	Number of dengue haemorrhagic fever cases
Chairulfatah, 2001[31]	Surveillance	Evaluate dengue surveillance system in Bandung (completeness of records at hospitals and regional health office (Bandung Municipal Health Office); Accuracy of diagnosis; Timeliness (delay in reporting to district health authority)	Surveillance system completeness, accuracy of diagnosis, timeliness	None measured
Chan, 2011[32]	Surveillance	Enhanced surveillance model based on time series data from official dengue case reports and Google search query volume for specific dengue-related queries	Validation correlations to assess model fit, using overall dataset and a holdout subset of data	None measured
Osaka, 1999[38]	Surveillance	Working staff in commune health centres and district hospitals requested to assess all febrile children and take blood tests to detect dengue specific IgM positive cases	None measured	Number of cases in the two study communes in 1997, comparison with annual rates in 1996 and 1997
Oum, 2005[39]	Surveillance	Syndromic surveillance using household surveys 1. Health Education: series of 3 day initial training workshops for village health workers and health staff before implementation of system; monthly half day refresher training; slides and videocassettes to recognise s/s, prevention and control strategies. 2. Household survey July 2001 to collect health data using standard questionnaire, validate with official case reports	None measured	Number of cases of haemorrhagic fever reported by CBSS compared to number in official reports; Number of cases treated at home vs health facility; Number of deaths reported by CBSS
Pang, 1989[41]	Surveillance	Sentinel surveillance program using more specific diagnostic criteria in case definition and serological screening of	% sero-positivity, % positive by virus isolation	None measured

		all selected patients suspected of dengue fever		
PREVENTION / CONTROL				
Ang 2007[44]	Chemical vector control (insecticide fogging and spraying), Environmental vector control (clean up) Education program & awareness campaign	Vector control: "carpet combing" which involved searching out and eliminating Aedes breeding sites in common outdoor areas, carried out as six 'exercises' in Sep and Oct; Health education: large community outreach exercise to educate the public to check and remove stagnant water in homes	None measured	Number of dengue notifications per week before and after each intervention using significance of regression coefficient for a dummy indicator
Beckett, 2004[45]	Education	educational program, lecture, handouts, posters	Dengue knowledge test scores	None measured
Butraporn, 1999[47]	Chemical vector control (temephos larvicide) Education program	Temephos supplied. Health education program included: lectures, discussions, field demonstrations to increase disease awareness & manage environment. 30 villagers formed into an "environmental master team" to peer-deliver program of four main training sessions, monthly meetings. Team "selected by villagers themselves" grassroots community support	Some knowledge results, but only cross-sectional; Larval indices: Breteau index, house index; Adult mosquito index: landing rates	None measured
Crabtree, 2001[48]	Environmental vector control (clean up) Education program & awareness campaign	Phase 1: workshops in which 24 community participants trained to conduct needs assessment for dengue prevention program (included transmission, breeding sites & cause and effect of vector, including dengue). Phase 2: participants conducted house-to house survey to identify problems, then prioritised and developed plan for prevention with emphasis on reducing breeding places. Activities included launch of campaign with advertising (signs, local news coverage), community inspections for breeding sites, dengue education of school	Rifkin (1998) participation framework score ; % household positive for adult vector	None measured

		children, community clean up, competition for cleanest house, public exhibition, videos & health talks for dengue, competition for cleanest house		
Eamchan, 1989[49]	Chemical vector control (insecticide fogging and temephos larvicide) Environmental vector control (clean up and container covers) Education program	Education: information sessions delivered by physicians to villagers explaining dangers of infection; Environmental: emphasise need to cover water jars, clean up discarded containers; Chemical: malathion fogging, temephos (1% abate sand granules)	Larval indices: House index, container index, Breteau Index	Number of dengue cases
Hien, 2011[52]	Environmental vector control (mosquito proof tanks and container covers)	Intervention: New mosquito proof tank containers installed & supply of plastic covers for existing containers; control= no intervention	Larval indices: HI, CI and larval density index (DI)	None measured
Igarashi, 1997[53]	Chemical vector control (impregnated curtains)	net impregnated with permethrin across all house openings	Adult mosquito indices: mosquito density index Acceptability	Number children with positive dengue serology: anti-dengue IgM antibodies
Kay, 2002[56]	Biological vector control (copepods) Environmental vector control (cleanup, recycling) Education program & awareness campaign	mesocyclops introduced to large outdoor concrete tanks & wells and distributed to households; community based control program included a system of local leaders, health volunteers, teachers and school children, supported by health professionals; recycling of discards for economic gain was enhanced plus 37 cleanup campaigns removed small containers; writing competitions & quizzes for children, training workshops for teachers, 110 community education & awareness meetings; campaign launch plus regular presentation of announcements via loudspeaker & news (TV and radio) coverage, 12,500 posters & brochures distributed	KAP indicators: % respondents with knowledge of dengue signs, transmission & control; Larval indicators: BI, % change in total larval population size Acceptability indicators	Clinical incidence dengue (per 1,000)
Kay, 2005[55]	Biological vector control (copepods) Environmental vector control	Mesocyclops introduced to 20-50 public wells / large water containers in each commune by commune personnel.	Adult mosquito index: percent reduction in vector (with total control = 100%)	Number of dengue cases

	(cleanup, recycling) Education program & awareness campaign	Health collaborators monitored progress and tested water monthly. Dengue control led by commune chairman & commune group leaders. Implemented by health personnel, collaborators, school teachers & pupils. Health collaborators undertook monthly inspection of houses, delivery of health education & reporting of suspected dengue cases, plus assisted with periodic clean up campaigns & mesocyclops distribution. Pupils involved in clean up campaigns, provided household support to aged/infirm, participated in dengue related activities (quiz, songs, football). A small projects scheme was set up for complementary businesses, including purchase of a recyclable waste compactor.		
Kay, 2010[57]	Biological vector control (copepods) Environmental vector control (cleanup and recycling) Education program & awareness campaign	Research program: Inoculation of mesocyclops, community environmental cleanup campaigns, health education & KAP surveys, community awareness campaigns, training of local project staff and collaborators Extended rollout program: Inoculation of mesocyclops, community environmental cleanup campaigns, health education, community awareness campaigns, training for health worker and collaborators	KAP indices Larval index: larval density Adult mosquito index: density index Cost of the intervention (total & per person) Sustainability rating (self developed tool)	Number of dengue cases
Kittayapong, 2008[58]	Biological vector control (copepods) Environmental vector control (clean up and container covers)	Cleanup campaign, screen covers for water jars, copepods, ovitraps. All targeted dengue foci	Larval index: CI; Adult mosquito index: landing rate	Number of serologically dengue positive children
Madarieta, 1999[59]	Chemical vector control (impregnated curtains) Environmental control (source	Permethrin-treated curtains provided at start of intervention. Larval surveys conducted at the start and thereafter	Larval indices: HI, BI, CI	None measured

	reduction)	every month for six months. Mentions health education but no details given. Elimination of breeding places also conducted during survey		
Nam, 1998[62]	Biological vector control (copepods) Environmental vector control (cleanup and recycling) Education program	Feb 1993 mesocyclops introduced to village well & large household containers/wells; March 1994 community intervention initiated included use of mesocyclops explained to village leaders, health workers & reps from women's & youth union to convey the information to all households, and recycling program intensified to ensure discarded/unused containers collected & removed from village frequently	Larval index: average number larvae per house Adult mosquito index: average number adults per house	None measured
Nam, 2005[61]	Biological vector control (copepods) Environmental vector control (cleanup) Education program & awareness campaign	Copepods. Cleanup. Community training (12 day workshop), monthly meetings. School teacher training; loud speaker announcements; local video shows, plays, folksongs, posters, pamphlets.	KAP indices Larval index: total larval population per 100 households Adult mosquito index: mean adults per house	Number of dengue cases
Osaka, 1999[38]	Chemical vector control (insecticide aerosols)	Vector control: Insecticidal aerosol cans in study area inside and outside patients houses and neighbouring houses June, July, Aug, Sep, Oct vs. ULV fogging Mar, May, Jul, Aug, Sep; Bloods collected to detect IgM pos cases.	None measured	Number of cases in the two study communes in 1997, comparison with annual rates in 1996 and 1997
Pengvanich, 2011[64]	Education program	Education: 2 day workshop; KAP survey: behaviour survey form, general interviews by local health officers; Larval surveys: CI and HI calculations	Larval indicators: CI and HI	Number of cases of DHF
Phan-Urai, 1995[65]	Biological vector control (Bti larvicide)	Tablet of Bti applied to water containers followed by larval surveys and adult mosquito collection over period of 7 months. Pre-treatment survey carried out once a month from Apr 8 – July 8 and then became twice a month after intervention. Four pre-treatment and eight post–treatment	Larval indicators: HI, BI, CI; Adult mosquito indicators: landing and biting rates	None measured

		surveys. Repeat treatment carried out whenever larvae found in containers.		
Phantumacinda, 2005[66]	Chemical vector control (temephos larvicide) Environmental vector control (source reduction) Education	Education: 3 day PH training course Nov 82 for health officers, workshop to organise vector control campaigns. Vector control campaign: Campaign week Feb, June, Aug 83, followed by larviciding and source reduction, then evaluation`	Number of houses treated, Larval indicators: BI	Number of cases of DHF
Suaya, 2007[69]	Chemical vector control (temephos larvicide) Awareness campaign	Twice a year large scale larviciding (temephos) campaign 2001-2005 targeted only to large household water containers.	Cost-effectiveness of intervention calculated as ratio of disability adjusted life years (DALYs) saved to the net cost of the intervention by year.	Number of dengue cases Number of dengue deaths Number of dengue hospitalisations
Suroso, 1990[70]	Environmental vector control (clean up and source reduction) Education	Health education: flip charts to schools, teacher training, posters, booklets, slides, films to increase awareness about source reduction campaign; School and community approach; Larval inspection techniques to calculate HI, CI and BI	Larval indicators: CI, BI and HI	None measured
Suwanbamrung, 2011[71]	Environmental vector control (clean up and source reduction) Education	Education: Doesn't make clear if 'leaders' received health education, but they assess this later pre- and post-intervention. Leaders also implemented dengue control activities in community, collected data for evaluation. Both groups participated in capacity building process. Qualitative assessment using interviews, focus group discussions, a form to collect people's perceptions of dengue problem, possible solutions, methods for sustainable prevention and control. Quantitative assessment: entomological indices using larval survey form to assess success of source reduction activities	Qualitative assessment: Dengue community capacity analysed with descriptive statistics. Range of mean scores for "domains" (14 leaders, 11 non-leaders) ranked into 5 levels (very low, low, moderate, high, very high). Leader and non-leader groups compared pre- and post-intervention for the three village settings Larval indices: HI, BI, CI	DHF morbidity (incidence rates) DHF mortality (deaths)
Swaddiwudhipong, 1992[72]	Chemical vector control (temephos larvicide and	**Health Education**: 1. Lectures, discussions to HC personnel, govt	Larval indices: HI, BI, CI	Number of cases of DHF Incidence rate of DHF (per

	insecticide spraying) Environmental vector control (clean up and source reduction) Education	officers, school kids, teachers, community members through community orgs; 2. Mass media (TV, radio, leaflets, local papers) - Mar 88; HE campaigns through house to house visits by trained health workers in Mar and June 89 and 90. **Vector control**: Spraying by MPH Mar and Jun 88, also 1-2 wks post home visit in 1989. Sale of Temephos to community when household visit. Larval surveillance: Prior to program start in Mar 88, then June 88, 1.5 months post home visit. Between 1989 and 1990 also at all schools in community		100,000 population)
Therawiwat, 2005[74]	Education	Education: ongoing training activities using problem identification and solving, active participatory learning and action with small group discussions; Larval surveys as a way to assess the main output of the program (elimination of mosquito breeding sites)	Education: Scores for knowledge, perception, self-efficacy, larval survey practices using an interview questionnaire; Larval indices: HI, BI, CI	None measured
Tun-Lin, 2009[76]	Philippines: environmental vector control (clean up & waste management) Myanmar: Biological (dragon fly nymphs & fish) and environmental (source reduction) vector control Thailand: Biological vector control (Bti larvicide) Intervention targeted to most productive water containers for vector breeding.	Philippines: tire splitting, drum and dish rack cleaning & waste management Myanmar: sweep method of container cleaning, dragon-fly nymphs & larvivorous fish Thailand: *Bti* (slow release) and pyriproxyfen every second month in productive containers Control areas received 'blanket' coverage of source reduction activities plus use of chemical control (Temephos) in both Myanmar and	Larval indices in BI and pupa per house index=PPI; % intervention coverage; Costs: recurrent and capital costs (Philippines & Myanmar only)	None measured

		Thailand		
Umniyati, 2000[77]	Environmental (source reduction)	Emptying and scrubbing positive containers covering pitchers with lids, eliminating discarded articles	Larval indices: BI for Ae. Aegypti and Ae. Albopictus; Adult mosquito indices: Ovitrap Index (OI) indoor and outdoor	None measured
Vanlerberghe, 2011[79]	Chemical vector control (insecticide treated curtains)	Vector control using insecticide treated curtains. Uptake at start of intervention to determine acceptability, follow-up surveys post curtain distribution to determine short term and continued use	Acceptance of intervention (measured by % uptake at distribution) and its determinants, Use of IT curtains (short term use at 5 months, continued use at 18 months) and its determinants	None measured

*Abbreviations: BI: Breteau Index, Bti: Bacillus thurigensis; CI: container index; DF: Dengue fever; DHF: Dengue haemorrhagic fever, DI: Density index; HI: house index; IT: Insecticide-treated; KAP: Knowledge, Attitudes and Practices; OI: Ovitrap index

Table 19: Dengue - Main findings and limitations of included studies

Main findings				
Reference	**Intervention group**	**Control group**	**Author's findings**	**Main limitations**
SURVEILLANCE				
Barbazan, 2002[28]	579 epidemic outbreaks (5.1% of total) identified over period of 11,388 province months (73 provinces x 156 months). This would have allowed focusing control activities on 5% of the months to potentially control 37% (308,636 cases) of the cases	No control group	herd immunity is important; epidemics could have been announced six months in advance; launch control strategies in dry season; national surveillance network is needed	data only available at a monthly and province level; no discussion of data quality and assurance processes; no accounting for spatial clustering of epidemics
Chairulfatah, 2001[31]	1. 199/650 (31%) hospitalised cases reported to local PHU; 2. Deaths 11/650 (1.7%) in hospitals vs. 5/199 (2.5%) reported to PHU; 3. 583 hospitalised cases had test performed (89.7%), 443/583 (76%) positive by serology 4. Of 199 cases reported to PHU, 151 (76%) had positive HI test	No control group	Surveillance system should be strengthened. Cases should be reported preferably after serological confirmation obtained	1. Underreporting to local PHU partly a reflection of case definition used (suspected DHF cases fulfilling criteria of clinical diagnosis) and request by Municipal Health Officials to report only patients with obvious DHF manifestations or confirmed diagnosis 2. Timely reporting not really assessed other than to say does not fulfil requirement to notify within 24h, as mail system used. Reporting on a range of time based on dates would have been more useful, but author admits dates not recorded
Chan, 2011[32]	Model predictions overall Pearson's correlation: Indonesia: 0.90 overall dataset, 0.94 holdout data subset; Singapore: 0.82 overall dataset, 0.94 holdout data subset	No control group	1. Models were able to adequately estimate true dengue activity according to official dengue case counts 2. Evidence of availability of novel data source that could supplement traditional surveillance 3. Low cost option, passive, requires minimal resources 4. Potential for earlier detection	1. Requires internet access - rural areas less likely to be served, developing countries less benefited 2. Captures all search queries, even ones from people who are not ill with dengue. 3. Panic-induced searching (e.g. In response to news of outbreak) increases noise 4. System remains susceptible to false alerts 5. Misdiagnosis obvious limitation
Osaka, 1999[38]	22/396 (5.5%) bloods collected in study area	43/758 (5.7%) bloods collected in control area	Active surveillance in	Both the intervention and control

	positive		combination with household use of insecticidal aerosol cans equally effective and less expensive than active surveillance combined with fogging	arm received the improved surveillance. Study designed to look at the impact of concurrent control interventions rather than improved surveillance. No information provided on the increased cost of active surveillance
Oum, 2005[39]	1. 16/49 (32.7%) cases of HF contacted health facility, 33/49 (67.3%) treated at home; 2. 2/10 (20%) deaths occurred at health facility vs 8/10 (80%) of deaths at home 3. two clusters of HF reported in one commune by CBSS;	No control group	CBSS captured more comprehensive and representative data for major diseases, detected disease outbreaks more frequently and more rapidly than routine disease surveillance system	1. Paper specifies Haemorrhagic fever, not DHF - includes other diseases that manifest as HF? 2. Sensitivity and PPV of CBSS assessed for other diseases but not HF. 3. Data from non-CBSS communes would have been useful to confirm value of CBSS 4. Authors admit mobile population difficult to collect health data from (e.g. farmers camping on their land) - houses > 1.5 km not visited. 5. Information on no. of household surveys per commune would have been useful to assess completeness of data capture. 6. VHVs motivated because financially rewarded. Sustainability?
Pang, 1989[41]	Clinic 1 (more specific CD): 176/525 (33%) positive by serology 28/56 (50%) positive by virus isolation Clinic 2 (PUO only): 6/85 (7%) positive by serology 15/97 (15%) positive by virus isolation	No control group	1. Involving private physicians contributes to more accurate surveillance of dengue activity, less underestimation of cases 2. Inclusion of certain diagnostic criteria improves positivity rate.	1. Did not compare and present data with rates obtained from cases diagnosed by other means e.g. Hospital setting within same area. 2. No information on demographic profile of patients and how they compare to other geographical areas within KL 3. More specific CD uses diagnostic criteria for DHF outlined by WHO so makes sense higher %s noted with CD used in Clinic 1. Not really contributing much.

PREVENTION / CONTROL				
Ang, 2007[44]	Average number of dengue notifications reduced by half a standard deviation as a result of the first exercise	No control group	1. First exercise provided greatest impact in reducing no. of dengue notifications independent of time component; 2. Reduction found to be greatest when carried out during dengue outbreak 3. There was a decreasing rate of returns from subsequent exercises	1. Exercises not carried out concurrently, and impact of operations on transmission could have differed with each exercise, so comparison may not be direct. 2. Final exercise coincided with decline in outbreak.
Beckett, 2004[45]	Av. Raw score post-test 10.1 42.5% good; 23.8% very good; 8.4% excellent; 4.0% very bad Mean raw scores: 8.90 primary, 9.67 secondary; 10.51 high; 11.35 college 45.6% related body aches/headache as symptom	Av. Raw score pre-test 7.8 39.9% fair; 38.4% good; 0.3% excellent; 1.4% very bad Mean raw scores: 6.27 primary; 7.38 secondary; 8.30 high; 8.96 college 12.6% related body aches/headache as symptom	intervention "appeared to" enhance knowledge and awareness of dengue; Improvement of individual scores strongly correlated with educational level	results from correlational analysis should be treated with caution as it is the wrong statistical method for this type of data; potential for confounding or interaction effect given Indonesian CDC's concurrent program of increasing awareness; low quality study
Butraporn, 1999[47]	HI 341.1 in Dec 98 to 120.2 Jan 00 BI 136.0 in Dec 98 to 40.8 Jan 00 LR 12.8 to 14.5	HI 297.9 to 270.5 BI 114.3 to 112.1 LR 8.7 to 11.7 (showed fluctuation interim measurements)	success in ensuring the sustainability of the dengue control program	low quality study; hard to know when intervention started; very little detail given about control village
Crabtree, 2001[48]	% houses positive for Ae. aegypti went from 60.4% to 13.3% (1 mth) to 21.5% (8 mth) in Beradek and 77.7% to 18.9% (1mth) to 18.3% in Semilang. % houses positive for Ae. albopictus went from 66% to 50% (1 mth) to 40% (8 mth) in Beradek and 69.6% to 36.9% (1mth) to 45.2% in Semilang.	no houses were positive for Ae. aegypti at baseline or 8 mth in the control village % houses positive for Ae. albopictus went from 87.5% to 57.1% (1 mth) to 52.4% (8 mth). No Ae. Aegypti was observed	Program effectively empowered community to take charge of its own health development. Project raised awareness of dengue & modified their behaviour. Challenge lies in sustainability	A reduction of vector also seen in control village - seasonal fluctuations related to mosquito breeding cycle may be confounding results. Increasing rates at 8mth may indicate lack of sustainability of program. Less impact seen for Ae. Aegypti
Eamchan, 1989[49]	Larval indices: HI: 20; CI: 5; BI: 33 Dengue cases: ~1100 cases reported mid-August in Nakhon Ratchasima. Epidemic in Village 4 peaked in August. All cases in August occurred before Aug 20, no later than one week after malathion spraying	Larval indices: HI: 67; CI: 30; BI: 221 Dengue cases: ~900 cases reported mid-September	Efforts at controlling mosquitoes with chemical (malathion and abate) and educational strategies met with limited success. Mass education and innovative methods of controlling environment needed.	Difficult to say how successful intervention was because it seems to be coinciding with natural progression of outbreak

Hien, 2011[52]	Average number of mosquito larvae per water container: 0 months: 0.98, 3 months: 0.42, 6 months: 0.61, 9 months: 1.56, 12 months, 0.66, 15 months: 0.25 2. Average number of mosquito larvae per tank: 3 months: 0, 6 months: 0, 9 months: 0.01, 12 months: 0.06, 15 months: 0	Average number of mosquito larvae per water container: 0 months: 1.07, 3 months: 0.35, 6 months: 0.48, 9 months: 1.12, 12 months, 1.45, 15 months: 0.61 2. Average number of mosquito larvae per tank: 3 months: 0.07, 6 months: 0.09, 9 months: 0.78, 12 months: 0.27, 15 months: 0.07	New water containers with net strongly prevented development of A. aegypti breading sites such as jars. They were accepted, used in a correct way by most householders and could be a sustainable measure for dengue vector control	1. Unequivocal for new tanks but little impact shown in other water containers and no impact on vector indices or disease measures (data not presented though). Old containers – particularly jars – still in use so no impact on vector indices
Igarashi, 1997[53]	A. aegypti density index (DI): March: 0.13, April: 0.17, May: 0.24, June – Dec: 0 each month Number of children positive for IgM (dengue antibody): April (before epidemic season): 1/78 (1.3%) positive, November (after epidemic season): 5/78 (6.4%) positive	A. aegypti density index (DI): March: 0.2, April: 0.24, May: 0.2, June: 0.41, July: 0.66, Aug: 0.68, Sep: 0.45, Oct: 0.27, Nov: 0.3, Dec: 0.14 Number of children positive for IgM (dengue antibody): April (before epidemic season): 4/78 (5.1%) positive, November (after epidemic season): 26/78 (33.3%) positive	Vector density index was reduced in all test areas after setting up the Olyset net compared with control areas, at least for several months; however, prevention of dengue virus by the net was not positively demonstrated because anti-dengue IgM antibodies did not show a significant seroconversion rate in the control areas; 100% householders agreed net is simple convenient and comfortable method of vector control	prevention of dengue virus by the net was not positively demonstrated because anti-dengue IgM antibodies did not show a significant seroconversion rate in the control areas
Kay, 2002[56]	KAP indices (% respondents 1998 to 1999): knew correct DHF symptoms = 54.9 to 71.7% knew correct DHF vector = 25 to 80.1% knew about reducing breeding sites = 6.5 to 56.2% knew about copepods for control = 2.6 to 65.1% Change in Breteau index (Apr 98 to Mar 00): urban Lac Vien 57 to 3, rural Nghia Dong 10 to 1; Xuan Kien 15 to 2, Xuan Phong 23 to 0 Change in larval population (% original numbers): urban Lac Vien 0.3%; rural Nghia Dong 0%; Xuan Kien 0.3%, Xuan Phong 0%	Change in Breteau index (Apr 98 to Mar 00): urban Gia Vien 53 to 35 rural Xuan Tien 25 to 30 Change in larval population (% of original numbers): urban Gia Vien 14.4%, rural Xuan Tien 367%	A previously successful campaign of education, community cleanup campaigns and promotion of recycling of discards for economic gain was able to achieve complete control of Aedes aegypti in 2 communes and efficacy >99.7% in a further 3.	High quality study across multiple communes. Good description of the intervention and larval survey methods. Limitations: Variable attack rates made the serological and clinical comparison of control and untreated communes problematic. Reliance on routine clinical data. Unclear whether intervention and control communes similar at baseline as less detail on control sites.

	Change dengue incidence per 1,000 1998-99: urban Lac Vien (urban) (0.68: 0) rural Nghia Dong (0.15:0); Xuan Kien (0:0); Xuan Phong (13.4:0) Acceptability indices: Acceptance of mesocyclops 97.8% Willingly take part in project 99.5%	Change dengue incidence per 1,000 1998-99: urban Gia Vien (0.18:2.1) rural Xuan Tien (0:0); Xuan Phuong (31.2:0); Tho Nghiep (13.4:0)		
Kay, 2005[55]	100% elimination of a. Aegypti in 32 northern communes by June 2003, with low numbers remaining in 5. No cases dengue reported since 2002. Average cost per person per year of program $US2, marginal cost of expansion estimated at 20 cents. Returns from small business projects fund a monthly allowance of $1.33 per health collaborator (as they are paid $2 this is not quite cost neutral)	dengue rates as high as 112.8 per 100,000 in surrounding untreated communes	Vector eradication has been achieved for communes and no dengue cases have been reported since 2002. Findings suggest strategy is sustainable and applicable where major sources of vector are large water containers.	High quality study with good description of intervention. Absence of control group but inclusion of 46 separate sites and follow up data of 3- 5 years.
Kay, 2010[57]	CENTRAL VIET NAM KAP indices (% respondents): knew correct DHF symptoms = 60.6% knew correct DHF vector = 98% knew about reducing breeding sites = 68.7% knew about copepods for control = 21.2% collected discarded containers = 55% regularly cleaned containers = 45% % large containers with copepods = 36% Density index for larvae = 1.51 Density index for adult mosquito = 0.03 Dengue cases: 2004: 0; 2005: 53; 2006: 0; 2007: 22 Costs (international dollars): $6,134 annually; 0.61c/person	CENTRAL VIET NAM – control area KAP indices (% respondents): knew correct DHF symptoms = 35.1% knew correct DHF vector = 62% knew about reducing breeding sites = 44.3% knew about copepods for control = 0% collected discarded containers = 30% regularly cleaned containers = 22.7% % large containers with copepods = 4.2% Density index for larvae = 17.8 Density index for adult mosquito = 0.12 Dengue cases 2004: 13; 2005: 36; 2006: 4; 2007: 66 NORTH VIET NAM – rollout program area KAP indices (% respondents):	The communes where the community-based strategy had been used were rated as well sustained with annual recurrent total costs (direct & indirect) of $0.28-0.89 per person.	Retrospective data collection for some elements of sustainability but otherwise high quality study with good description of methods and participants. Supplementary material available about sustainability measurement tool in separate published article.

	Sustainability score: 4.42 of 5 NORTH VIET NAM KAP indices (% respondents): knew correct DHF symptoms = 50% knew correct DHF vector = 82% knew about reducing breeding sites = 74.5% knew about copepods for control = 76.2% collected discarded containers = 94% % large containers with copepods = 80.3% Density index for larvae = 0 Density index for adult mosquito = 0 Dengue cases: No local cases since 2003 Costs (international dollars): $3,098 annually; 0.28c/person Sustainability score: 4.20 of 5	knew correct DHF symptoms = 45.5% knew correct DHF vector = 79% knew about reducing breeding sites = 57.6% knew about copepods for control = 60.5% collected discarded containers = 96.1% % large containers with copepods = 55.4% Density index for larvae = 0 Density index for adult mosquito = 0 Dengue cases: No local cases since 2000 Costs (international dollars): $10,736 annually; 0.89c/person Sustainability score: 3.69 of 5 NORTH VIET NAM – control area KAP indices (% respondents): knew correct DHF symptoms = 43.6% knew correct DHF vector = 48% knew about reducing breeding sites = 25% knew about copepods for control = 2.3% collected discarded containers = 97.1% % large containers with copepods = 68% Breteau index for larvae = 38 Density index for adult mosquito = 0.3 Dengue cases: No local cases since 2003		
Kittayapong, 2008[58]	% positive containers went from around 38% to close to 0%. Mosquito landing numbers went from around 1 to close to 0	% positive containers went from around 25% to 50%. Mosquito landing numbers went from around 3.5 to 2	Intervention worked well (but is pilot study). Mapping of cases for targeted vector control should be feasible (although may be too expensive to get this data on a wider scale). Larger cluster RCT	No mention of whether data was collected by people who were blinded to treatment group. Not a randomised study.

	Sero positive children went from 13.5% to 0%.	Sero positive children went from 9.4% to 19.2%.	needed.	
Madarieta, 1999[59]	Results by month Aug-Jan House Index: 46/65 (70.7); 31/66 (46.9); 19/61 (31); 23/64 (35); 14/63 (25.4); 31/63 (33) Average decrease of HI: 36.4% Container Index: 85/382 (22.3); 52/452 (11.5); 33/428 (7.7); 36/325 (11); 25/270 (9.3); 31/314 (9.8) Average decrease of CI: 12.4% Breteau Index: 131; 78.8; 54; 56; 33.3; 46 Average decrease of BI: 77% Two-tailed test showed difference in decrease of indices between intervention and control group was significant	Results by month Aug-Jan House Index: 34/65 (52.3); 22/63 (34.9); 25/67 (37); 12/64 (18.7); 14/65 (21.5); 19/67 (28.3) Average decrease of HI: 24.2% Container Index: 64/389 (16.5); 45/411 (10.9); 45/436 (10); 16/321 (4.9); 22/215 (10.2); 26/346 (7.5) Average decrease of CI: 7.7% Breteau Index: 98.5; 71.4; 67; 25; 33.8; 38.8 Average decrease of BI: 51.3%	Indices in both barangays dropped but greater percentage decrease noted in intervention group. Difference in decrease significant. Treated curtains effective vector control measure against dengue fever	Low quality study. No results presented on population, household size, household characteristics and number of dengue cases. Also no results on test of significance, so don't know what numbers they used. Intervention confounded by elimination of breeding sites and health education, so don't know what impact the curtains had on their own. Author says: "Increase in indices in intervention group in 4th and 6th month because some households had changed and washed curtains. By the sixth month, >60% of households had washed curtains once and 52% of households were not using their curtains anymore". Difficult to say how successful the curtains were.
Nam, 1998[62]	Number of cement tanks with copepods went from 87% to 95% and ceramic jars went from 56% to 83%. Number of larvae/house was 30-97% less in intervention village than control village after copepod introduction; it was 87-99% less after community involvement initiated; since August 1994 (5 months post community involvement) no larvae have been observed. Number of adult mosquitoes in village was 30-100% less than control village after copepod intervention; it was 87-99% less once community involvement initiated; since	both larvae and adult vector persists in control village, numbers follow a routine cyclical seasonal pattern, no other trend observed	Eradication of vector possible	No data on dengue infection and cases

	August 1994 only a single adult observed in November, then absent for 2 years			
Nam, 2005[61]	93.9% improvement in Mesocyclops knowledge, 66.1% improvement in knowledge of dengue symptoms. 95% reduction in mainly small containers that could act as a breeding site. Larvae density reduced from 2466-10759 in Sep 2000 to 0-11 in Jun 2003 Adult mosquito index reduced from 0.12-1.16 in Sep 2000 to 0-0.01 in Jun 2003 Disease incidence dropped from 55.2 per 100,000 in 2000 to zero in 2003	Larval density reduced from 2568 in Sep 2000 to 960 in Jun 2003 Adult mosquito index reduced from 0.65 in Sep 2000 to 0.40 in Jun 2003 Disease incidence in surrounding district went from 58.1 per 100,000 in 2000 to 14.4 in 2003	Success in eliminating clinical dengue infections.	Not much detail in control communes. Small study.
Osaka, 1999[38]	morbidity in serologically confirmed DHF cases 17 cases/110 febrile patients (15.5%) in peak month of study (August) Reduction in dengue morbidity rates 1996>1997 was 56>16 cases (71.4%) Cost US$393	morbidity in serologically confirmed DHF cases 8/138 (5.8%) in peak month of study (August) Reduction in dengue morbidity rates 1996>1997 was 89>43 cases (51.7%) Cost US$553	Insecticidal aerosol cans for household use equally effective and less expensive than ULV fogging	1. Only population and household #'s given for demographic profile. Difficult to say if two areas comparable (no age/sex breakdown, SES, education level, etc. (use of chi-square test only appropriate if comparable). 2. Unclear if active ingredients in aerosol cans vs fogging: comparable or different insecticidal potencies 3. Intervention in study and control areas done at diff times 4. Comparison of incidence rates needs historical mean of at least 4 yrs to compare (1996 may have been unusually high year) 5. People in study area used a no. of insecticidal interventions (sticks, cans, including diff cans to those provided??) 6. 15% of people in control area used aerosol cans > difficult to assess effectiveness of intervention 7. Diff in no. of pos

				cases between areas: some diff in some months, overall no diff.
Pengvanich, 2011[64]	CI 11.86 > 0.24, p < 0.001; HI 62.31 > 3.21, p < 0.001; DHF rates did not vary during time of study	CI 10.52 > 6.81; HI: 60.63 > 54.03	long term vector control should be based on health education and community participation, requires support from authorities	No information on KAP survey completed by participants; program assessed control of dengue vectors, but did not have effect on DHF rates, which are influenced by other factors (seasonal pattern, interaction from existing program) ; also mentions incidence DHF in the region small; failure to complete 2d course by some family leaders, substitution by other members; also mention family leaders had problems with filling in larval survey form, so means this information was self-reported rather than filled by trained staff
Phan-Urai, 1995[65]	Indices quoted below: pre-intervention, thereafter % reduction after treatment (2nd, 4th, 6th, 8th, 10th, 12th, 17th week and average) HI (%): 85, 56.5, 62.4, 48.2, 69.4, 84.7, 84.7, 83.5, 69.4, 69.8* (*p<0.05) CI: 51.8, 71.0, 76.8, 73.0, 82.6, 92.3, 94.2, 96.1, 86.5, 84.1 BI: 76.0, 77.9, 69.3, 81.8, 82.8, 94.0, 95.1, 87.9, 84.4 Landing rate: 8.1, 43.2, 48.2, 88.9, 80.2, 66.7, 87.6, 88.9, 87.6, 73.9 Biting rate: 5.2, 42.3, 38.5, 88.5, 86.5, 65.4, 80.8, 65.4, 80.8, 94.2, 92.3, 73.6 Bti product effective longest in drinking water containers (because water not replenished as often) 16.4 +/- 2.5 larvae free weeks	Indices quoted below: pre-intervention, thereafter % reduction after treatment (4th, 8th, 12th, 14th, 17th week and average) HI: 86.5, -0.6, 2.9, 20.2, 22.5, 11.2 CI: 44.8, 10.7, 28.6, 37.5, 44.2, 35.6 BI: 344.5, 16.1, 30.0, 44.8, 51.5, 43.1 Landing rate: 8.2, 35.4, 24.4, 51.2, 54.9, 30.2 Biting rate: 5.8, 36.2, 22.4, 48.3, 65.5, 41.5	Bti formulation effective and practical for control of Aedes aegypti larvae	Pilot study of Bti in small number of households. Good description of the methods used for evaluation. Low quality study. Short study duration and no contextual data on the delivery of the program. Cannot control for seasonal differences in vector population
Phantumacinda, 2005[66]	Urban: # houses treated: 70-86%; amt larvicide used 65g/premise;	Rural: # houses treated: 81-86%; amt larvicide used 76g/premise;	students made better volunteers than village participants (>future	No info on demographic. profile of municipality or rural areas.

	reduction BI post Nov and Feb campaign 60% and 70% based on pre-control index; reduction in rate of DHF 22.2/1000 > 11.3/1000	reduction BI post Nov and Feb campaign 45% and 78/63% based on pre-control index; reduction in rate of DHF 47.4 and 56.5/1000 > 3.0 and 7.3/1000	school campaign); std program required, not just periodic mass campaigns; larviciding water jars unpopular, so coverage good but not extensive (100% coverage not achieved because of this); prevalence of larval breeding reduced by 60-80% but BI still higher than 100; periodical larvicidings not economical or practical	Greater no. volunteer participation in urban areas contributed to more houses treated (performance bias). Acceptability of larvicide impacted on uptake (assessment of compliance). Long term change in practice and activities not assessed following awareness campaign, only evaluated campaign. Probably better comparing one village to another with t-test rather than rural vs urban. Other factors that influence rates of DHF.
Suaya, 2007[69]	Number of dengue cases reduced by 53%. Annually averted 2980 hospitalisations, 11,921 cases and 23 deaths, resulting in a saving of 997 DALYs per year. Gross cost of intervention $US 567,800 per year ($US 0.20 per person covered).Annual net cost $US312,214 ($US 0.11 per person covered)	No control group	Annual targeted larviciding campaigns appear to be effective and cost-effective medium-term interventions to reduce epidemiologic and economic burden of dengue in urban areas of Cambodia	Study undertaken over 5 years in "real world" setting with 5 years of pre-intervention data available. Limitations: 1. Number of cases of dengue, morbidity indicators and costs are all calculated based on ratio of dengue cases in intervention area relative to elsewhere in Cambodia, however, rates of dengue were very different in the two areas at baseline. 2. Epidemiologic data were not available below province level, meaning that 27.6% of the population who received the intervention were classed in the control group for outcome data. 3. data sources for dengue incidence came from hospital surveillance systems so would have missed many less severe cases. 4. in some control areas educational campaigns and distribution of temephos was undertaken by an NGO.

Suroso, 1990[70]	Post-intervention: Premise Index: School 14.3%; school child's house: 4.9%; other house: 6.0%. CI: School 25.3>14.7%; school child's house: 11.8>8.6%; other house: 18.2>8.7%; BI: School 74>42%; school child's house: 29>19%; other house: 45>19%	Pre-int.: Premise Index: School 37.6%; school child's house: 9.4%; other house: 30% CI: School 25.3%; school child's house: 11.8%; other house: 18.2%; BI: School 74%; school child's house: 29%; other house: 45%	Results show possible to reduce BI, CI and HI. Smaller reduction in schools and school kids houses reflect lower motivation of school kids to participate.	Low quality data, only one time pt pre- and post-test. No control study area. May be other reasons for reduction (season, for example).
Suwanbamrung, 2011[71]	Total community capacity level for leader group (mean, SD): BM community high (389, 11) BN community high (357, 10) BK community high (406, 12) Total community capacity level for non-leader group (mean, SD): BM community high (263, 52) BN community moderate (218, 62) BK community high (290, 54) Larval indices: BM community BI130; HI 45; CI 22 BN community BI 140; HI 44; CI 12 BK community BI 65; HI 31; CI 5 Dengue cases (number:rate/100,000 population:% morbidity) year 2010 BM community (3:202:0) BN community (2:118:0) BK community (0:0:0)	Total community capacity level for leader group (mean, SD): BM community high (351, 15) BN community moderate (297, 16) BK community high (352, 15) Total community capacity level for non-leader group (mean, SD): BM community moderate (247, 72) BN community moderate (196, 70) BK community moderate (242, 35) Larval indices: BM community BI 303; HI 51; CI 24 BN community BI 350; HI 55; CI 31 BK community BI 358; HI 63; CI 25 Dengue cases (number:rate/100,000 population:% morbidity) years 2007, 08, 09 BM community (0:0:0), (0:0:0), (1:67:0) BN community (2:18:0), (1:59:0), (0:0:0) BK community (1:61:0), (3:182:0), (1:61:0)	Model with highest community capacity level showed low risk on dengue index using both entomological and epidemiological indicators. Levels of improvement pre and post-intervention were dependent on the context of each community.	Attempts to compare the three villages unreasonable because very different settings. Morbidity rates pre- and post-intervention unreliable, the number of cases is small and rates will fluctuate wildly with every extra or less case.
Swaddiwudhipong, 1992[72]	Number of larval containers at schools reduced during study (11.3 to 0.7 in kindergartens, 7.9 to 0.7 in primary schools, 23.0 to 2.0 in secondary school) 1988: all 3 indices reduced by 40-50% when measured in June 88: HI: 79>49.1; CI: 39.1>22.4; BI 240.9>126.1, Indices recovered to same high levels in	No control group	1. HE efforts made more sig reductions of mosquito population in epidemic year (1990) than in inter-epidemic yrs (1988, 1989). 2. Decreasing trend of larval containers detected after each household visit, mainly attributable to increasing proportion covered containers. 3. Majority of larval habitats	1. Difficult to say how large contribution HE had as reduction had as much to do with larvicidal effect of temephos (~3mths). Also can be seen with increase of larval indices with onset of rains. But some increase in covered containers, so played some part 2. Reduction in 1990 despite no spraying carried out (no funds),

	Mar89 (HI: 70.4, CI:34.4, BI:216.7). Reduction in Apr +Jun89, then increase in Aug89 coinciding with rains.		comprised water-holding containers for household use and ant-traps. 4. Dec larval indices in bathing and washing containers because of temephos applications, not HE.	but also to do with publicity surrounding DHF outbreak announcement in Feb90. 3. HE appears to have been most effective in schools.
Therawiwat, 2005[74]	N=132 Knowledge scores 6.87 to 9.58 Perception score 9.45 to 11.27 Self-efficacy score 29.10 to 31.77 Larvae survey practices score 0.30 to 0.90 All significant (p< 0.001) CI from 21.3 > 4.1 > 3.24 HI from 77.3 > 19.7 > 6.8 BI from 367> 100.7 > 49.2 Top five breeding places (container types) similar in intervention and control areas. Post-intervention regression analysis showed best predictor of larval survey practices was participation in study program (b=0.455, e-0.518), knowledge regarding DHF (b=0.096, e=0.033), age of participant (b=0.019, e=0.033).	N=155 Knowledge scores 7.09 to 7.46 Perception score 9.35 to 9.67 Self-efficacy score 28.5 to 29.21 Larvae survey practices score 0.34 to 0.39 CI from 20.3 > 20.1 > 19.6 HI from 67.7 > 61.3 > 60 BI from 261.6 > 259.3 > 276.8 Pre-intervention regression analysis showed community status best predictor of larval survey behaviour practices (beta=0.469, eta=0.468), followed by educational level (b=0.179) and male sex (b=0.089)	Program successful. Knowledge, perception, self-efficacy, larval survey practices in intervention group higher than before test and compared to control group. CI, HI, BI decreased sharply and confirmed effectiveness of study program.	Scoring system not explained. Program was targeted at key community stakeholders, so not surprising educational level and sex predictors of high scores at the start, as they are likely to be both more educated and male. Would have been useful to report on DHF incidence in the year post intervention.
Tun-Lin, 2009[76]	Percent reduction in BI and PPI: Myanmar: 82.2% (BI), 76.3% (PPI) Philippines: 80.3% (BI), 73.2% (PPI) Thailand: 51.8% (BI), 14.8% (PPI) % coverage (proportion productive containers reached): Myanmar:73.5%; Philippines:70%; Thailand:80% Cost per household: Myanmar $4.47; Philippines $9.32	Percent reduction in BI and PPI: Myanmar: 81.8% (BI), 78.4% (PPI) Philippines: 75.8% (BI), 73.1% (PPI) Thailand: 51% (BI), 48.6% (PPI) % coverage (proportion productive containers reached): Myanmar:75%; Philippines:70%; Thailand:80% Cost per household: Myanmar $6.45; Philippines $2.19	Targeted interventions were as effective as non-targeted, and were cheaper	No untreated control group, so observed changes could be due to other factors that changed over time.
Umniyati, 2000[77]	OI indoors 48.5% > 23.3% at 6wks (X^2 Mantel Hantsel=7.12, p<0.05);	OI indoors 34.4% > 37.2% at 6wks; OI indoors 37.2% > 29.9% 12wks;	source reduction done by community for 18 wks able to	Source reduction decreased OI indoors and outdoors in dry

	OI indoors 23.3% > 28.2% 12wks (X^2=0.06, p>0.05); OI outdoors 54.1% > 32.1% at 6wks (X^2=8.79, p<0.05); OI outdoors at 12wks X^2=0.12, p>0.05)	OI outdoors 35.2% > 30.2% at 6wks (X^2=0.51, p>0.05)	reduce significantly the OI and BI of Aedes species.	season, not much difference in rainy season with respect to control areas. Conventional fogging more effective in rainy season (but by X2 not significant) BI reduced at 6wks, 12 weeks and remained low at 18wks with respect to control area. No information if control and exp areas were comparable or why selected. No info on appropriate sample size. No information on profile of the two villages (demographic, etc) No information on how housewives were trained. Also does not say who conducted surveys and assessed the traps
Vanlerberghe, 2011[79]	1. 92.3% of households accepted at least one curtain in March 07, 80.1% using curtains at 5 months and 59.7% at 18 months. Uptake positively assoc with residency > 5yrs (Odds ratio 3.5 (1.7-7.3). 2. At 5 months, use determined by perceived effectiveness of IT curtains (odds ratio 2.2 (1.2-4.1) and low SES (odds ratio 5.3 (2.8-10.0); 3. At 18 months, use determined solely by perceived effectiveness (odds ratio 4.9 (3.1-7.8).	No control group	1. High initial uptake remarkable. 2. Disease knowledge not correlated with uptake or use (not surprising, high % of people had good knowledge), therefore educational messages may not be helpful to assure sustained high coverage, other strategies required. Active engagement of community in promotion of continued use may be an avenue. 3. Assoc between continued use and perceived effect needs investigating, and this could have been done with qualitative component to study. 4. Drastic decline of curtain use at 18mths limits introduction of IT curtains into dengue control programs.	1. 33.6% Loss to follow-up for last survey due to seasonal workers moving out of Laem Chabang. Possibly could have stratified by this variable to look at characteristics of two populations. 2. Authors did not explore determinants around "perceived effectiveness"

Table 20: Dengue - Contextual information extracted from included studies

Reference	Qualitative information		
	Contextual factors	Behavioural mechanisms	Program details
SURVEILLANCE			
Barbazan, 2002[28]	None reported	None reported	Surveillance data obtained from CDC Thailand. Financial support from DTEC, Thailand, Mahidol University, Dept of Societies and Health, IRD, France
Chairulfatah, 2001[31]	No resources to do recovery of virus tests (more definitive than serology)	Doctors wished to postpone reporting until diagnosis confirmed. Health municipality officials often asked to report only patients with obvious s/s DHF/DSS	Financial support from Belgian Ministry of Development Cooperation (part of Inter-university Program of Cooperation between Flemish Inter-University Council and Padjadjaran University, Bandung
Chan, 2011[32]	None reported	None reported	Funded by Google, Inc. two of the authors are employees of Google, Inc (competing interests)
Osaka, 1999[38]	More simple serological tests may be required in more peripheral areas	None reported	Patients treated at commune health centers or district hospitals. Insecticidal aerosol cans provided by Dainihon Jochugiku Co; Fogging conducted by team sent from preventative medical centre in central province.
Oum, 2005[39]	1. Official health staff sometimes not receptive to village health volunteers' efforts; 2. VHVs motivated because financially rewarded.	None reported	Financial assistance from European Commission and MOH Cambodia
Pang, 1989[41]	None reported	None reported	Supported by International Development Research Centre, Canada, WHO, Ministry of Science, Technology & Environment, Malaysia, University of Malaya. Monoclonal antibodies provided by Walter Reed Army Institute of Medical Research, Washington
PREVENTION / CONTROL			
Ang 2007[44]	Strategy carried out in response to dengue outbreak in 2005	None reported	Operation let by National Environmental Agency with 6000+ volunteers from various govt agencies, town councils and grassroots organisations. Public education pamphlets distributed to homes by 10,000 volunteers.
Beckett, 2004[45]	Study budget did not allow comprehensive public health educational program. Extreme elderly not surveyed (maximum age 59 years)	None reported	Program supported by US Naval Medical Research Center, Indonesian National Institute of Health Research and Development
Butraporn, 1999[47]	Dengue endemic in the area, no plumbed water (most households could not afford the 4000-6000 Baht fee for piped water supply), poor wastewater	Villagers had good knowledge of DHF but remained unconvinced of effectiveness DHF control programs as sustainable control failed. Objective of EMT was to	Environmental Master Team established to forge links at local level through district administration. Comprised of 30 members from different blocks. EMT

	management	establish good linkages between villagers and public health workers.	selected own team leaders and advisers and worked on voluntary basis. Assisted by experts from Health Department
Crabtree, 2001[48]	National top down dengue-prevention program in place, but unsuccessful. Villages predominantly agricultural, high risk of dengue, intervention villages had significant problems managing refuse whilst control village more hygienic, all villages had no piped water supply & rely on containers	Program strategy of gotong royong (grass roots community action) appeared to promote a sense of community cohesion and shared directions and objectives. Workshop participants were mainly young men & women, which challenges the heavily patriarchal system of the communities. Tendency of communities is to rely on government intervention to address environmental & infrastructure issues which threatens sustainability of changes to attitudes & behaviour	Participation in project & raised awareness gives spin off benefits for community in terms of civic pride, general well being, more effective networking and self-advocacy with government agencies and wider community
Eamchan, 1989[49]	1987 proceeded independent of rainfall (rains delayed till September). Increased water storage by villagers because of severe water shortage. All villages were heavily infested with dengue mosquito vectors. High price of larvicides and insecticides in developing countries compromises efforts at control	Villagers objected to smell of abate in drinking water. Lack of understanding and cooperation from villagers.	Initiative of Epidemiology Division of the Ministry of Public Health
Hien, 2011[52]	Dengue endemic, high incidence of dengue, rising rates dengue morbidity and mortality	None reported	WHO research support
Igarashi, 1997[53]	Dengue endemic with epidemics in wet season.	100% of householders agreed net is simple, convenient and comfortable method of vector control	Industry sponsored funding. Routine anti-vector health education and control measures ongoing
Kay, 2002[56]	High frequency of concrete tanks and wells meant habitats amenable to treatment with mesocyclops Large water tanks and wells identified to establish local source of mesocyclops. Public information broadcasts via loudspeaker got a better response in rural communes than in urban where this was thought to distract attention from media (TV, radio & news) announcements	Was important to gain political and communal support for interventions prior to roll out. Communities believed that dengue and dengue haemorrhagic fever were dangerous so were willing to participate. Community recycling projects for economic gain were established. Residents were extremely willing to participate in community-based activities for vector surveillance and control. Urban communities were more sceptical of health information from project staff than rural residents. Personal visits were valued more highly than public broadcasts. Once patients and health staff appreciated that serological diagnoses would be provided in a timely manner (<7 days) the number of clinical patients providing blood rose to 100%	Trained volunteers used to carry out education and awareness. Paid project staff used for KAP and entomological surveys. Careful choice of volunteers and leaders important. Teachers and schoolchildren were particularly important in success of cleanup activities. Rural residents developed closer relationship with the project team than urban dwellers. Mesocyclops requires >12 months to become effective.
Kay, 2005[55]	In one province, the program receives VND 10 million	Health collaborators paid $US2 per month for duties	Institutional staff, project team staff & advisors

	from local authorities in recognition of wider community benefits of dengue control Water supply based around large tanks suitable for mesocyclops control - unlikely to be as effective in cities with reticulated water and greater waste management issues but could be used in focused areas such as tyre piles. Copepods are a natural resource existing in most communes and can be produced at low cost	(approx 4 days work) & given uniform. Micro financing for recycling businesses with some of the returns from small business projects given to commune to cover dengue project costs School children adept at recognising larvae and copepods and engaged with ongoing servicing for the community Hierarchical structure of society in Viet Nam aided successful adoption of model Perceived seriousness of dengue by communities was motivating factor.	supervised implementation through provincial, district and commune level staff. Consent obtained from community leaders. Monthly support provided by project officers attending local project management meetings & undertaking KAP surveys, attending communal functions, running commune training for health collaborators & school teachers, development of school programs & guidance to commune level
Kay, 2010[57]	Although program achieved eradication of vector in northern communes, difficult to claim reduction in dengue morbidity due to epidemic nature of disease	Study showed direct linkage between frequency of collaborator visitation and knowledge of dengue prevention and practice. Stipends for collaborators ($3.83 per month) were not motivation for being collaborator, motivation may come from pride in being part of program - prestige and affection given to collaborators. Community perceived dengue as a resurgent problem. Microcredit schemes were catalysts for sustained cleanup activities. Local leaders key to success and sustainability	Roll out to new communes without input from original technical project staff has shown that technical instruction is required before roll out to new communes. Use of copepods less effective without complementary health education and environmental sanitation activities.
Kittayapong, 2008[58]	All vector control tools were locally produced.	Water jars main mosquito breeding sites. Education was needed to make sure people used jar covers.	Combination of governmental top-down and community-based bottom-up approaches.
Madarieta, 1999[59]	Both barangays highly endemic for dengue fever. Barangays were similar in demographic and socioeconomic variables, also similar number of dengue fever cases	Knowledge of preferred containers as breeding places aids health worker in conducting the information, education and communication campaign. Increase in indices in intervention group in fourth month and in sixth month because some households had changed and washed curtains. By the sixth month, >60% of households had washed curtains once and 52% of households were not using their curtains anymore.	Larval collection by entomological teams accompanied by barangay officials and health workers.
Nam, 1998[62]	Mosquito coils, spray cans of insecticide also in household use; recycling is an important economic activity	Way water storage containers were used enabled copepods to be kept with minimal effort ; community involvement & recycling were important	Use of Mesocyclops requires minimal time, expertise and effort. The cost of providing copepods is small & can be produced locally. Only small numbers needed but effectiveness is ensured by getting into as many containers as possible in short time
Nam, 2005[61]	Local community management committees responsible for the intervention (played key role in	Attitude and willingness of community volunteers contributed to success	Not collected

	mobilising community). Motto of "no larvae, no dengue". Large jars (2000l) make it impossible to simply empty water. Continuous community inputs are required post-project to prevent reinfestation		
Osaka, 1999[38]	None reported	Advantages of aerosol cans are: Timing - people can undertake themselves and don't have to wait for centrally based fogging units Community participation - individual protection may protect community neighbours Ease - cans can be used with no training inside and outside the house	Patients treated at commune health centers or district hospitals. Insecticidal aerosol cans provided by Dainihon Jochugiku Co; Fogging conducted by team sent from preventative medical centre in central province.
Pengvanich, 2011[64]	Dengue endemic in the region.	None reported	Support from PH personnel and local public health volunteers from respective communities. Community leaders from each community also invited to meetings
Phan-Urai, 2005[65]	Mountainous, fruit growing region; No plumbed water. Wells and water containers used to capture rainwater. Average annual rainfall 300mm.	Good cooperation from community members. No complaint about the product (Abate larvicide rejected by some, particularly for drinking water because it is oily, also concerns about hazardous nature of chemical in their drinking water). Bti formulation perceived as safer to humans.	Survey team consisted of one scientist and five mosquito scouts (two officers and three volunteers). Joint project between Ministry of Health and Mahidol University
Phantumacinda, 2005[66]	Dengue endemic in regions selected	Increasing refusal to use temephos because of unpleasantness in drinking water	Visual larval surveys conducted by technical staff of Div. of Med Entomology, Bangkok. Involvement of district health officers, village chiefs, village scouts, health communicators, school teachers, students, individual families. House to house visits by volunteers (village chiefs, village scouts, health communicators, students). Temephos provided by Govt. Methoprene provided by Zoecon Corp
Suaya, 2007[69]	First round of larviciding occurred 1 month before the start of the main transmission season.	None reported	Budgetary constraints meant that the second round of larviciding was restricted in 2003 & 2004 to locations with a high incidence of dengue (40% of original locations). Program received financial support from NGOs, Ministry of Health, and World Bank. Implementation was through provincial health agencies and NGOs with use of temporary employees for mass distribution of larvicide
Suroso, 1990[70]	None reported	Lack of motivation among school children	Community approach through local Women's Club and community leaders. These trained up as

			volunteers to give health education and perform larval inspections by Health Centre officers (local govt of Pekalongan). School campaign with assistance of Health Centre officers. Orientation meetings with teachers and students. Mainly health education
Suwanbamrung, 2011[71]	High DHF morbidity rate in the three regions	Good acceptance of the program from village community	Leader group consisted of village health volunteers, representatives of dengue health promoters, local authority/organisation networks, schools, temples. "Non-leaders" were community members. Leader groups trained by research team
Swaddiwudhipong, 1992[72]	None reported	None reported	1. trained health workers from Mae Sot General Hospital and DoH of the Municipal Office conducted h-t-h visits. 2. Community organisations included temple membership, Rotary Clubs 3. ULV spraying by Dept of CDC, MPH
Therawiwat, 2005[74]	Mueang district had the highest incidence of DHF. Efforts to control Aedes mosquitoes have been redirected from local health services at provincial level to community-based control using village health volunteers.	Interaction between the key stakeholders and between stakeholders and researcher enhanced reflection and dialogue of the stakeholders.	Stakeholders included village health volunteers, village headman, community schoolteachers, sub-district health officers, and Tambon (sub-district) Administration Organisation (TAO) members.
Tun-Lin, 2009[76]	Tropical humid climates Productive containers differed by site: Philippines: large tanks, tires, drums & waste Myanmar: large tanks, drums & religious vases Thailand: large tanks, clay jars & toilet tanks	None reported	Costs of targeted intervention were higher in the Philippines because of the strong component of social interventions, but these costs should decrease after the initial mass campaigns and equipment purchases. Sites in the Philippines and Thailand had a dedicated research team, in Myanmar the program was run through the Ministry of Health
Umniyati, 2000[77]	Dengue endemic in the region	None reported	Community participation through DHF working groups at village level under supervision of health centre. One of members is Family Welfare Education Women's Movement
Vanlerberghe, 2011[79]	Climate tropical, heaviest rains May – October, dengue endemic in the region. Considerable proportion seasonal workers in this city	None reported	110 village health volunteers, supervised by municipal vector control program (team of 5) and a team of Chon Buri's regional disease control office. Occasional support from Municipal hospital team. Vestergaard-Frandsen provided IT tools

Table 21: SARS - Study characteristics of included studies

Reference	Study characteristics					
	Setting	**Design, study type**	**Length of observation**	**Study population**	**Sample size**	**Research question**
Escudero, 2005[34]	Singapore	Retrospective cohort survey medical records	one month (1-28 September)	Tan Tock Seng Hospital staff members	4,261 staff	Evaluate the practicality of post-SARS surveillance recommendations in previously SARS affected countries
Goh, 2006[51]	Singapore	Retrospective analysis of outbreak case series	3 March to 27 April (outbreak)	Singapore community	12,194 SARS contacts general population 4.25 million	Describe the functioning of the SARS contact tracing, isolation and quarantine procedures
Ooi, 2005[63]	Singapore	Retrospective analysis of outbreak case series	March – May 2003 (outbreak)	Contacts exposed to a probable SARS case served with a home quarantine order	12,194 contacts under surveillance. 7863 contacts on home quarantine, 4331 on daily telephone surveillance	Effectiveness of quarantine management processes
Tan, 2006[73]	Singapore	Retrospective analysis of outbreak case series	March – July 2003 (outbreak)	Singapore community	12194 SARS contacts 0.5 million children	Effectiveness of contact tracing and quarantine and school temperature screening in detecting SARS cases
Tuan, 2007[75]	Viet Nam	Retrospective analysis of outbreak case series	26 February – 28 April (outbreak)	Contacts of laboratory confirmed SARS cases	252 contacts of 45 index cases (222 completed the study)	To evaluate risk of transmission outside the healthcare setting to household and community contacts of laboratory confirmed SARS cases

*Abbreviations: SARS: severe acute respiratory syndrome

Table 22: SARS - Details of interventions and outcomes evaluated in included studies

Type of intervention				
Reference	Type of intervention	Description of intervention	Type of outcome measure	
	Categorise into broad groups		Process/output Indicators	Infection outcomes
Escudero, 2005[34]	Surveillance	Surveillance of staff sick leave via electronic medical certificates; specifically, sick leave, repeated sick leave or prolonged (>3 day) sick leave for febrile illness (surveillance of inpatients also evaluated but results not reported here as outside scope)	Speed of reporting MCs*	Episodes of staff medical certificates for febrile illness; prolonged and repeated MCs, clusters of MCs
Goh, 2006[51]	Isolation & quarantine	Key strategy was to detect suspected or probably SARS as early as possible and isolate them in hospital Closure of Pasir Panjang wholesale market, 2007 workers/visitors put under home quarantine	interval between onset of symptoms and isolation	number of new infections
Ooi, 2005[63]	Quarantine	Home quarantine order for contact of probable cases of SARS for a period of 10 days from last exposure, monitor temperature twice daily and provide updates via phone. Quarantine could be at home or in a designated facility. Enforcement done by random phone checks using electronic cameras to check location. Allowance of $US41/day given to individuals under quarantine and salaries reimbursed to employers of small businesses forced to close.	Proportion people breaking quarantine Cost quarantine	Infection yield from quarantine
Tan, 2006[73]	Isolation & quarantine	Wide net surveillance and isolation policy (from 22 March) – used a broad definition for suspicious cases, rapid contact tracing, telephone surveillance or home quarantine for contacts. Mandatory temperature screening in schools (from 30 April – 25 July).	Average duration between onset of symptoms to isolation Percentage of probable SARS cases previously identified as suspect Percentage of probable SARS cases previously under quarantine or surveillance	Resolution from outbreak Proportion of children diagnosed with SARS detected by screening
Tuan, 2007[75]	Use of masks	wearing of mask during contact with case		cases of SARS transmission

*Abbreviations: MCs: medical certificates

Table 30: SARS - Main findings and limitations of included studies

Main findings			
Reference	**Intervention measure**	**Author's findings**	**Main limitations**
Escudero, 2005[34]	167 fever medical certificates were observed; (rate of 1.40 per 1,000 staff days observed); 40 (24%) had documented temperature >=38 degrees Celsius; prolonged (31) and repeated (12) medical certificates were uncommon; in temperatures >38 there were only 2 clusters of two staff; 81.4% of fever MCs were reported on day of issue and 15.6% on day after; only 5 had a delay of 2 or more days.	Documented fever is rare in sick leave amongst staff so a system for monitoring of febrile illness is practical and likely to be effective. Other than looking for clustering, other early surveillance signals could include staff with prolonged MCs, repeated MCs and high fevers. Surveillance is time-consuming and current recommendations are not specific enough to be used practically.	No knowledge of aetiological agents involved including in clusters. Short period of surveillance. Unclear how surveillance indicators influenced by seasonal trends, especially clusters due to influenza outbreaks. Study coincided with admission of an isolated case of SARS from a laboratory accident which may have heightened awareness of febrile illness. No data on sensitivity and time-sensitivity
Goh, 2006[51]	average time between onset of symptoms and isolation week 3-9 March 6.8 days week 31 March – 6 April 2.9 days week 21 – 27 April 1.3 days No spread of infection to other wet markets	Singapore has further strengthened its operational readiness and laboratory safety to respond to SARS. The robustness of the system was demonstrated in the early detection, isolation and contact tracing of all contacts when a laboratory-acquired SARS case was diagnosed in September 2003.	Descriptive study only, only summary data provided. Based on outbreak data
Ooi, 2005[63]	Cost of large-scale quarantine operations in 2003 $5.2 million. Most persons served with a home quarantine order understood and complied with quarantine. 26 (0.3%) person broke quarantine 58 SARS cases detected amongst 12,194 people under surveillance giving a yield of 0.48%	Large numbers were quarantined for a very low yield – efficiency could be improved by improving the specificity of criteria used in defining the contacts for quarantine. Imposition of large-scale quarantine should be implemented only under specific situations in which it is legally and logistically feasible.	Descriptive study only. Based on outbreak data
Tan, 2006[73]	Average duration between onset of symptoms to isolation decreased from 6.8d in week 2 to 1.3d in week 9. Percentage of probable SARS cases previously identified as suspect increased from 0% in week 2 to 88% in week 9. Percentage of probable SARS cases previously under quarantine or surveillance increased from 0% in week 2 to 100% in week 9. In total, 58 of 206 probable SARS cases had been on quarantine orders prior to diagnosis. Outbreak was halted.	The wide net approach to surveillance and isolation of suspected cases was effective in ensuring progressively earlier isolation of probable SARS cases as the outbreak progressed. The challenge is to reduce the numbers that need to be quarantined without decreasing the effectiveness of the measure. Despite extensive effort, none of the children diagnosed with SARS were detected by temperature screening.	Descriptive study only, limited data, multiple interventions in place. Based on outbreak data

	No children diagnosed with SARS were detected through temperature screening	However, it is likely that the screening procedures had a powerful psychological effect of reassuring parents and the public that schools were safe during the outbreak	
Tuan, 2007[75]	7/156 people who never wore masks developed SARS versus 0/9 people who sometimes/mostly wore masks. This factor was not significant in multivariable analysis (only physically caring for the case was a risk factor).	Physically caring for a symptomatic laboratory confirmed case was the only independent risk factor for SARS transmission	95% of contacts reported never wearing a mask. Based on outbreak data

Table31: SARS - Contextual information extracted from included studies

Reference	Qualitative information		
	Contextual factors	**Behavioural mechanisms**	**Program details**
Escudero, 2005[34]	Based within a tertiary healthcare facility	Staff with medical background may have different patterns for seeking medical certificates	electronic medical certificate and leave records available
Goh, 2006[51]	Factors contributing to success included: Strong political leadership; Adequate resourcing; Electronic systems	Factors contributing to success included: Effective command; High levels of professionalism; Strong community support	Factors contributing to success included: Prompt coordinated interagency response; Collaboration with international agencies
Ooi, 2005[63]	Government support committed necessary resources to overcome legal and operational obstacles.	Those quarantined were agreeable to being confined at home. Stigmatisation of quarantined individuals by neighbours was reported.	Proper systems within an organisational framework to allow resources to be deployed effectively. Other disease investigation routines and health promotion activities were able to be put on hold. Health education by visiting nurses, electronic surveillance and financial incentives contributed to the low rate of noncompliance.
Tan, 2006[73]	Surveillance, isolation and quarantine policy worked particularly well due to epidemiological features of SARS, namely patients are symptomatic when infectious and risk of transmission increases with duration of illness – in other words there is little asymptomatic SARS infection or transmission, and SARS is transmitted predominantly through close contact and droplet spread.	Necessity of being able to adapt rapidly to changing information and circumstances. Importance of rapid and accurate information collation and transmission to guide decision-making	Timely and transparent provision of information and local updates was important. Government played crucial role in explaining quarantine strategies to public, successfully engaging the public and mobilising governmental and community bodies to assist in the fight against SARS. Better and integrated IT systems developed during the outbreak greatly facilitated the containment strategy.
Tuan, 2007[75]	None reported	None reported	None reported

Table32: Avian influenza - Study characteristics of included studies

Reference	Study characteristics					
	Setting	Design, study type	Length of observation	Study population	Sample size	Research question
Azhar, 2010[27]	Indonesia	Retrospective analysis of surveillance data	3 years: January 06 – March 09	Population of Bali, Java, Sumatra, much of Sulawesi and all of Kalimantan	341 districts, population not reported	Establishment of a sustainable community-based program within provincial and district livestock services to guide prevention and control activities for the control of HPAI
Bhandari, 2011[46]	Cambodia	Prospective cohort	Two years	11 provinces in Cambodia	2000 families in 100 rural communities	Develop an effective intervention mechanism with local project partners to mitigate the impact of HPAI
Desvaux, 2006[33]	Cambodia	Retrospective analysis of surveillance data (animal)	6 months: July – December 2004	Markets in 7 provinces; 12 provinces for village & farm surveillance	712 samples from markets; 51 commercial farms; 75 villages and farms	Main objective to enable veterinary services to detect new HPAI outbreaks in different sectors without relying solely on existing and inadequate passive surveillance system
Jost, 2007[35]	Indonesia	Prospective analysis of surveillance data (animal)	12 months: Jan 2006 – Jan 2007	Population of the islands of Java, Bali and two provinces of Sumatra	350 districts, 60 trainers, 3 master trainers, population not reported	Program objective to implement rapid response tied to early detection through active surveillance – identification and containment of outbreaks in backyard and small scale operations

Manabe, 2011[60]	Viet Nam	Before/after intervention comparable cohorts, intervention and control group	3 months: Baseline KAP survey Dec 09; post-intervention survey Mar 10	Two agricultural communities in Ninh Binh province, Yen Son and Ninh Hoa (intervention and control groups)	323 participants in intervention 417 (Yen Son) and 418 (Ninh Hoa) pre-intervention completed KAP survey 264 (Yen Son) and 288 (Ninh Hoa) post-intervention completed KAP survey	To develop an effective educational program to enhance awareness of H5N1 and motivate people to access to health care earlier when H5N1 infection is suspected or likely
Perry, 2009[42]	Indonesia	Retrospective analysis of surveillance data (human & animal)	3 years: 2006 – 2009	Java, Bali, Kalimantan, Sulawesi and Sumatra	As of May 09, program in 27/33 provinces, 20,000 villages (30%), 2.5 million poultry producers, 2000 PDSR officers	Evaluation of the Participatory Disease Surveillance and Response (PDSR) program of the FAO of the UN in Indonesia
Samaan, 2005[43]	Countries covered by WPRO office#	Retrospective analysis of web search data	40 days: 20 Jan – 26 Feb 04	National population of countries?	Not reported in the article	Whether enhanced rumour surveillance can a) offer timely assistance to potentially affected nations, b) prompt countries to undertake preparedness measures, c) inform public and international community about relevant events
Van Kerkhove, 2009[78]	Cambodia	Prospective cohort before/after intervention	2 years: Jan 06 – Dec 07	Two southern provinces of Cambodia: Kampong Cham and Prey Veng	1252 adults > 15 years old (452 in 2006, 800 in 2007)	To evaluate changes in poultry handling behaviours since first survey (Jan 2006) and post educational campaigns (Dec 05)
Waisbord, 2008[80]	Three countries in the Mekong Region: Viet Nam, Cambodia, Lao PDR	Prospective cohort with KAP surveys pre- and post intervention	Viet Nam: Apr – Sep 2007? Unclear when study ended	Whole of Viet Nam population Whole of Cambodia	Viet Nam: 3840 district and commune women's union officers	Collaboration with local civil society groups to mount behaviour change

			Cambodia: Unclear. Baseline KAP surveys conducted Nov – Dec 05 Lao PDR: Feb 06 – Mar 07	population Whole of Lao population	Cambodia: 810 village promoters Lao PDR: 93 reporters and editors	communication interventions

includes Brunei Darussalam, Cambodia, Lao PDR, Malaysia, the Philippines, Singapore, Viet Nam

Table33: Avian influenza - Details of interventions and outcomes evaluated in included studies

Type of intervention				
Reference	**Type of intervention**	**Description of intervention**	**Type of outcome measure**	
	Categorise into broad groups		**Process/output Indicators**	**Infection outcomes**
Azhar, 2010[27]	Establishment of a surveillance system	Training of PDSR officers to conduct surveillance on village-wide basis (diagnose HPAI compatible events; control outbreaks through culling, carcass disposal, decontamination, movement control; collect and submit laboratory samples; raise community awareness; prepare response plans with community; assign disease status to each village	Number of officers trained Coverage of villages where activities completed Number of villages visited	Number of villages infected
Bhandari, 2011[46]	Education	Training, public education, networking, promoting model farms. One village health worker in each community participated during project implementation. Formal and informal training provided to all project partners and project recipients.	Number of outbreaks of HPAI in the region	None measured
Desvaux, 2006[33]	Targeted active surveillance system	Monitoring of markets (assess sanitary status of village poultry sector, detect possible illegal movement of sick animals); - samples every 2 weeks in province and once a week in Phnom Penh, 1 Aug – 1 Dec 04 Clinical surveillance of semi-commercial poultry farms (broilers and laying hens) of former outbreak areas; Sentinel villages monitoring system (strengthen surveillance at village level, improve knowledge of village poultry mortality); - one village per province, post February 2005 Serological surveillance of domestic duck farms - monthly sampling on duck farms, post March 2005	Market monitoring: number of HPAI-positive samples Broilers and hens: number of HPAI-positive samples Distribution of farms according to the risk of having faced an HPAI outbreak	None measured
Jost, 2007[35]	Establish an active surveillance system, education	Veterinary participatory disease surveillance officers trained to conduct surveillance on village-wide basis to detect HPAI events and enhance the national surveillance system	Number of HPAI events detected	None measured
Manabe, 2011[60]	Education	Educational intervention consisted of lectures, songs, practical performances, interactive quiz. KAP survey conducted in both groups with a face- to-face interview by trained local healthcare workers. KAP scores were compared between the different time points and between groups. How educational intervention	Frequencies between intervention and control groups for a number of variables KAP scores between intervention and control groups	None measured

		influenced awareness relating to H5N1 and accessibility of healthcare in the population was analyzed.		
Perry, 2009[42]	Surveillance evaluation	Desk study to review all relevant background information Visit to Indonesia to meet with staff, visit project sites. Field visits complemented by two surveys conducted April-May 09 by Indonesian NGO CREATE	Number of PDSR officers trained Coverage in villages Number of HPAI outbreaks detected Number of outbreaks/events controlled Number of villages declared infection free	None measured
Samaan, 2005[43]	Surveillance	Enhanced rumour surveillance for reports of avian influenza H5N1. Rumour surveillance officer assessed media sources and email-based public health discussion, regularly contacted WHO network to identify rumours. Each rumour followed up by email or telephone request to relevant WHO country office to investigate veracity	Number of rumours identified Number of true and false events Average period for verification of true and false events	None measured
Van Kerkhove, 2009[78]	Education	Training programs for the Village Animal Health Workers in the area by FAO and NaVRI following domestic poultry H5NI outbreaks since 2004. Training was to assist in a passive surveillance system of domestic poultry using village animal health workers to identify and report acute high mortality in poultry.	Change in likelihood to perform a certain behaviour	None measured
Waisbord, 2008[80]	Viet Nam: Education; Behaviour modelling by key staff Cambodia: Education Lao PDR: Education	Viet Nam: Two planning workshops in Apr 06 by representatives of Viet Nam Women's Union (VWU) from 64 provinces. Train the trainer workshops for VWU officers in 24 provinces Training of over 3840 district and commune women's union officers by the trainer. Workshops covered poultry health, human health, AI prevention and control. Posters and leaflets also distributed, covering the above as well as quarantining, fencing poultry 9800 group discussions held between May - Sep 07 (reaching estimated 240,000 women) Behaviour modelling: key staff in women's unions required to practice AI preventative measures Provincial women's unions expected to integrate AI prevention	Viet Nam: Pre and post intervention KAP scores Cambodia Unknown Lao PDR: Unknown	None measured

		activities into clubs, credit and savings groups, community groups Cambodia 810 village promoters trained by Centre d'Etude et de Developement Agricole Cambodgien (CEDAC), reaching over 1,300 villages in 8 priority provinces. Village promoters then held at least one, one-day workshop. Representatives of commune councils also participated, then hosted workshops to other commune council members and village chiefs Lao PDR: 93 reporters and editors from Lao Journalists Association (LJA) trained in 3 day workshop in three provinces Training covered information on Lao National Strategic Plan on Avian Influenza, AI prevention and control. More focused, smaller workshop held in Mar 07 for 13 journalists to develop media production plans, coverage and outputs on AI (6 news articles, 60-second animated spot, documentary)		

Table34: Avian influenza - Main findings and limitations of included studies

Main findings				
Reference	**Intervention measure**	**Control measure**	**Author's findings**	**Main limitations**
Azhar, 2010[27]	1. Number of officers trained: 48 by May 06, 1200 by May 07, 2100 by May 08 2. As of Mar 09, PDSR program operational in 76% (341) of districts in Indonesia 3. 19,673 villages where PDSR activities have been completed 4. 25,525 villages where surveillance activities have been completed, 1455 of these resulting in diagnosis of HPAI 5. 2766 villages completed control activities 6. 13,775 villages completed prevention activities 7. 7640 completed monitoring activities 8. 1,961,089 community members participating in PDSR activities 9. As of Mar 2009, 2.5% (490/19,673) villages infected with HPAI, 8.1% (1598) suspected infected, 3.1% (612) controlled and 86.3%(16,973) apparently free of infection	None	1. PDSR project has expanded participatory activities to enable all key stakeholders to have a voice in the prevention and control of HPAI from local communities to district, provincial and central governments. 2. Methodology has evolved to provide disease detection in village-based poultry sector 3. Major success of program has been strengthening of field activities of local veterinary authorities and improvement in veterinary/farmer interface	No evaluation of how successful the training to the officers was (e.g. KAP surveys) No information on what surveillance was in place prior to the program (assume none?) No information was given on the cost or long-term sustainability of the program
Bhandari, 2011[46]	100 farmers participated as demonstrators of the model and as initial recipients. No outbreaks reported in the communities in the project areas	Between the years 2004 – 2008, 20 outbreaks reported in Cambodia	Educating rural, resource-deficient families about proper biosecurity measures for the prevention and control of HPAI is the entry point for mitigating the disease. Grassroots education to model good practices to	Low quality study. Training program was not evaluated. Authors mention project was monitored using their own model (Participatory Self-Review and Planning Toolkit), but no results

			control diseases of public health importance	presented. Participant selection done through "Heifer model of participant selection", but no information is given here. Also no information on situation before program initiated
Desvaux, 2006[33]	Market monitoring: 0/712 samples collected in 7 provinces Clinical surveillance of broilers and laying hens: 0/51 farms under surveillance were positive Sentinel village study: May – June 2004: interviews conducted in 52 villages and on 23 farms. 70 villages and farms classified according to their risk of having faced an HPAI outbreak. 14/70 (20%) not suspected, 3/70 (4%) low probability, 18/70 (26%) moderate probability, 35/70 (50%) high probability	None	Several constraints identified during implementation of program: lack of motivation of provincial staff, limited capacity of central team to compile and analyse data generated, weak diagnostic capabilities, reluctance of farmers to have animals sampled. Education and training appear essential and should be applied at each level of a monitoring and surveillance system. This represents a significant investment	Investment in training and education appears to not be sufficient (field staff collecting wrong swabs) Selection of animals in market places biased Sample sizes were below defined levels, hence not representative Evaluation of performance of surveillance system needed.
Jost, 2007[35]	Program first implemented in 2006 in 12 districts. By May 2007, program covered 159 districts 800 HPAI disease events detected in first 12 months. In Jan 2007 alone, 236 active HPAI events confirmed by rapid test found in 49/121 districts	None	PDS has allowed decision-makers to gain a clear and accurate picture of the disease status of their country Participatory epidemiology has achieved significant institutional change, leading to revitalised animal health services	Minimal information on training program; no information of evaluation of training program. Appear to be preliminary results of program
Manabe, 2011[60]	Main source of information for both groups was the television; greater proportion of participants reported receiving information from healthcare worker (42.0% to 68.1%, p<0.001), friend (14.6% to 30.6%, p<0.001), advertisement of women's association	Proportion of participants reported receiving information from healthcare worker (54.3% to 33.0%), friend (13.8% to 14.8%), advertisement of women's association (34.2% to 22.7%), newspaper (22.0%, 15.5%) in control group Changes in knowledge, attitude and	The study indicated an increased awareness of H5N1 and increased reliance on local health care workers. More people sought early access to healthcare, which resulted in earlier medical intervention for patients with H5N1 avian influenza infection.	Results variable. Percentage of participants reporting the educational intervention not always increased post-intervention. Educational intervention evaluated by a qualitative survey using face-to-face interview of only 16 participants from Yen Son commune.

	(28.3% to 68.8%, p<0.001), newspaper (22.5% to 32.6%, p<0.001) after intervention Other changes in knowledge, attitude and practice: H5N1 transmitted from birds (88.5% to 80.8%, p<0.001) Bury all dead poultry (88.0% to 91.7%, p<0.001) Use protective clothes when burying (82.7% to 72.8%, p<0.001) Throw away dead poultry (4.1% to 1.8%, p<0.001) Wash hands after slaughtering (97.8% to 94.2%, p<0.001) Seek immediate treatment if develop fever after contact with poultry (86.3% to 90.2%, p<0.001) Multi-variate analysis showed that KAP scores influenced by initial score, education level and the intervention. Having a higher education level was strongly correlated with largest difference in KAP score, and score of intervention group differed by 8.69 points from control group (95% CI 7.26-10.11))	practice in control group: H5N1 transmitted from birds (88.2% to 93.1%) Bury all dead poultry (75.6% to 74.6%) Use protective clothes when burying (77.5% to 27.5%) Throw away dead poultry (10.0% to 16.3%) Wash hands after slaughtering (96.0% to 80.8%, p<0.001) Seek immediate treatment if develop fever after contact with poultry (82.0% to 68.3%, p<0.001)	Study indicated that habits such as touching and eating dead/sick poultry were reported at both pre- and post-intervention. Main impact of educational intervention was to increase people's trust in local healthcare providers Interest in avian influenza increased.	Some differences in intervention and control group (control group reported a higher proportion of farmers) and also differences in participants pre- and post-intervention in intervention commune (greater proportion of participants reported a higher economic level post-intervention)
Perry, 2009[42]	52 Master trainers delivered 88 training sessions to PDSR officers as of Jun09; PDSR program good coverage: 27/33 provinces, 20,000 villages (30%), 2.5 million poultry producers; Surveillance effective in detecting disease: May 08 - Feb 09: Majority of visits were	None	PDSR program achieved reasonable coverage, with both passive and active surveillance visits adequately represented Most villages have tendency to progress from infected to free/controlled Villages in majority of provinces not likely to revert from "Controlled' status to become 'Infected' or 'Suspect villages.	Methodological shortcomings of original PDSR database and subsequent revisions in early 2008 make comparison of data difficult. Results shown are based only on new PDSR database, with evaluation team relying heavily on reports from the FAO/CMU epidemiology unit for the

	scheduled or active (86.6%, 16,268), 13.4% (2512) were report (passive surveillance) visits, but they were more effective in detecting disease (5.6% vs 94.4% of HPAI cases); Two thirds of passive surveillance visits were as result of community reports. Outbreaks seasonal, confined to small number of households in village (<25%); Traders, unsafe disposal of carcasses and contaminated vehicles sources of infection. High level of co-operation noted during field visits, (96.2% of total response activities coordinated May 2008 – Feb 2009 PDSR program not so successful in control activities for variety of reasons (no compensation, inability to enforce movement control); PDSR Education component also successful: 1 Mar 2008 - 26 Feb 2009, 29,476 education meetings held with community leaders, 10,093, 6,804, 103,832 and 9,971 meetings held with groups of community members, other organizations, individual households and persons from commercial enterprises, respectively. Meetings covered 17 areas related to HPAI prevention		PDSR response alone insufficient and unlikely to contain and eliminate the disease because response mechanisms undertaken by officers are very weak; Greater engagement with commercial poultry sector required, disproportionate focus on backyard poultry sector Need for transition into more sustainable and responsive animal health services	interpretation of data. Evaluation questioned the validity of some variables, such as decontamination variable, percentage of farmers reporting movement restriction, when anecdotal information suggests ongoing sale of sick birds.
Samaan, 2005[43]	Total of 40 rumours identified from 20 Jan – 26 Feb 2004 from 12 countries and 1 SAR	None	Rumour surveillance informed immediate public health action and prevented unnecessary and costly responses	Includes media and email-based public health discussion. Persons without resources or access to information

	48% from media, 18% from WHO network, 5% from embassy staff, 2% from Pro-Med 23% of rumours confirmed to be true events Average period of verification of true events was 2.7 days (1 – 5 days), 9.3 days for false events (1 – 26 days)			technology will not be captured by this form of surveillance
Van Kerkhove, 2009[78]	1. Reporting poultry mortality to village chief 61.8%, p=0.03 2. Reporting to animal health worker 223.6%, p=0.002 3. Preparing dead/sick poultry for consumption (60.7%, 43.8%, p>0.001) 4. Burning dead poultry (36.5%, 26.5%, p<0.001) 5. Burying carcasses (82.5%, 84.8%, p<0.001) 6. Touching poultry with bare hands (337/800, 42.1%, p<0.001) 7. Using dead domestic poultry for consumption (108/800, 13.5%, p<0.001) 8. Collecting dead wild birds from field for consumption (36/800, 4.5%, p=0.002) 9. Using poultry faeces for manure (494/800, 61.8%, p<0.001) 10. Allowing children to play with poultry (205/800, 25.6%, p=0.06) 11. Washing poultry products in water sources (99/800, 12.7%, p<0.001)	1. Reporting poultry mortality to village chief 27.8% 2. Reporting to animal health worker 72.2% 3. Preparing dead/sick poultry for consumption (35.0%, 20.0%) 4. Burning dead poultry (2.9%, 1.4%, p<0.001) 5. Burying carcasses (59.4%, 61.2%, p<0.001) 12. Touching poultry with bare hands (339/450, 75.3%) 13. Using dead domestic poultry for consumption (203/450, 45.1%) 14. Collecting dead wild birds from field for consumption (37/450, 8.2%) 15. Using poultry faeces for manure (347/450, 76.8%) 16. Allowing children to play with poultry (92/450, 20.4%) 6. Washing poultry products in water sources (6/450, 1.6%)	Reporting to village chief increased and animal health officer decreased (possibly village chief known, health worker perceived to be government and may cull poultry) Awareness of AI high, understanding of transmission low Improvements in basic hygiene practices, reduction in risky poultry handling behaviours Some risky behaviours still persist (allowing children to play with poultry, proper treatment of poultry in household environment) and this needs to be addressed in future public health campaigns	Differences in sampling methods in 2006 and 2007 surveys Villages and persons in 2006 survey different in 2007 survey Poultry handling behaviours self-reported Some demographic differences between two study populations
Waisbord,	Viet Nam: 167 training workshops	Viet Nam:	Nascent civil societies can provide rich	Viet Nam:

2008[80]	held in 19 provinces for over 3,800 key women's union staff 8,300 fencing posters, 8,300 poultry separation posters and 1.9 million leaflets distributed. Results from 41 districts in 21 provinces: total average post-test score 91.7% Cambodia: 75,000 farmers trained and educated on prevention and control of AI. 274,000 people received AI prevention information, 9% of farmer households set up model farms Lao PDR: AI coverage has improved in quality and quantity (now weekly AI programs on TV and radio)	Total average pre-test score 54.5%	institutional resources to support difficult changes in health and animal husbandry practices Approach focused on collaborating with existing institutions and was successful	Limited information on assessment of effectiveness of intervention, other than the one pre- and post-test score Cambodia: Assessment was carried out on effectiveness of intervention, but results not presented Lao PDR: No formal assessment carried out No data on evaluation of Cambodian and Laotian program presented

Table35: Avian influenza - Contextual information extracted from included studies

Reference	Qualitative information		
	Contextual factors	Behavioural mechanisms	Program details
Azhar, 2010[27]	Because of its contribution o strengthening local government veterinary services, Indonesian government considering role of PDSR in larger context of livestock development	None mentioned	Program funded by international donors through emergency schemes (USAID, AusAID, the Japan Trust Fund, the World Bank-administered Policy and Human Resources Development Fund provided by Japan, multi-donor Avian and Human Influenza Facility).
Bhandari, 2011[46]	Heifer active in Cambodia since 1984, providing assistance for community development, poverty alleviation, food security for rural families. Cambodia reported 20 HPAI outbreaks from 2004 – 2008, with the deaths of 21,000 birds, and seven human deaths.	None mentioned	Program funded by Heifer International. Heifer Cambodia worked through local project partner non-governmental organisations to select project families
Desvaux, 2006[33]	No regulatory framework for the control of animal diseases, so no compulsory declaration of an infectious disease can be enforced. Furthermore, veterinary officers cannot enter farms or declare suspicions of animal diseases	Farmers reluctant to get their animals sampled. Financial incentives were proposed to motivate village animal health workers to declare suspect poultry mortality	"Different agencies, under the umbrella of the Food and Agriculture Organisation, are providing support to the Cambodian Government"
Jost, 2007[35]	Local people have rich and detailed knowledge about the animals they keep and the diseases that affect them (termed "existing veterinary knowledge"). Further, researchers often do not know or understand the local context.	None mentioned	Program funded by US Agency for International Development. Other partners included the Indonesian National Veterinary Services, Indonesian Ministry of Health, Animal Health Service, Food and Agriculture Organization of the United Nations.
Manabe, 2011[60]	Study indicated importance of involvement of local healthcare workers and administrators in H5N1 education and outreach.	Changing behaviours and customs is difficult, especially for residents in rural areas with a one-time educational intervention.	Work supported by the Japan Initiative for Global Research Network on Infectious Diseases from the Ministry of Education, Culture, Sports, Science and Technology of Japan. Cooperation also from the Health Department of Ninh Binh province, healthcare workers in Ninh Binh province and medical providers at Bach Mai hospital in Hanoi
Perry, 2009[42]	PDSR had very positive impacts on revitalising veterinary services in Indonesia, particularly strengthening local animal health services (Dinas), also on empowering communities' access to public services. PDSR has injected new lease of life into understanding of and responsiveness to animal health constraints of many rural and urban communities	Authors report historical divide between much of poultry industry and Government livestock services, characterised by poor communication and mistrust, with deleterious effect on HPAI control. Recently poultry industry has become progressively more involved in dialogue on HPAI control with Government. Authors still comment that difficult to obtain	Evaluation prepared by the FAO Evaluation Service. PDSR funded by Australia, Japan and United States. Collaborative effort with involvement and representation from the Ministry of Agriculture, (Directorate General of Livestock Services, the Directorate of Animal Health (DAH) and the Campaign Management Unit (CMU); Staff from Provincial and District Dinas, including LDCCs and PDSR officers; representatives from Ministry of Health, the Ministry of Internal Affairs and KOMNAS; Representatives of poultry producers; Staff from sister UN agencies (WHO, UNICEF) dealing

	Opportunity to use these models initiate the national process to consider evolution of sustainable veterinary services	adequate representation from the different sectors of industry, particularly from sector 3. Poultry movement control is extremely difficult to implement in Indonesia in general, and in the backyard poultry sector in particular. The PDSR database shows all HPAI confirmed cases movement control was implemented, but discussions held with farmers in field visits show clearly that selling of surviving chickens is widely practiced.	with HPAI issues; and, Development partners and donors implementing/funding HPAI activity in Indonesia
Samaan, 2005[43]	Impact of rumours can be great, for example, introducing bans on importation, heightening surveillance in other animal or human populations	None mentioned	Conducted as a joint project between WHO's Western Pacific Regional Office Team and the National Centre for Epidemiology and Public Health at the Australian National University
Van Kerkhove, 2009[78]	Educational efforts that succeed in raising awareness and knowledge about disease transmission and risk do not always succeed in increasing likelihood of reporting to authorities. Because of this, issues such as compensation have to be considered, especially in Cambodia where compensation for culling not provided	None mentioned	Prior to sampling, field visits conduced with provincial veterinarians and village chiefs to explain study. Written consent obtained in 2007 survey (verbal in 2006) Assistance by National Veterinary Research Institute, Institut Pasteur
Waisbord, 2008[80]	Viet Nam: pre-test scores varied widely among provinces with a range of 20% - 80%, likely reflecting regional differences in animal health worker practices	Cambodia: Participants observed that training brought commune council people together and provided opportunity to network and cooperate more closely in the future	Program developed by The Academy for Educational Development under a contract with the US Agency for International Development (USAID) Program delivered in Viet Nam by the VWU, in Cambodia by CEDAC, in Lao PDR by

Appendix V – List of excluded studies by disease and reasons for exclusion

Rabies – articles

Akoso BT. Rabies in animals in Indonesia. In: Rabies control in Asia, Dodet B, Meslin FX, editors, 2001. p 219.
Reason for exclusion: Descriptive analysis, no intervention

Ali M, Canh DG, Clemens JD, Park JK, von Seidlein L, Thiem VD, *et al.* The vaccine data link in Nha Trang, Viet Nam: a progress report on the implementation of a database to detect adverse events related to vaccinations. Vaccine. 2003 Apr; 21(15):1681-6.
Reason for exclusion: Vaccine safety surveillance

Anonymous. WHO strategies for the control and elimination of rabies in Asia. Report of a WHO interregional consultation, Geneva, Switzerland, 17-21 July 2001. World Health Organization Technical Report Series 2002;2001 (WHO/CDS CSR/EPH/2002.8)
Reason for exclusion: No data on interventions

Arámbulo PV, 3rd. Veterinary public health: perspectives at the threshold of the 21st century. Revue Scientifique Et Technique (International Office Of Epizootics). 1992; 11(1):255-62.
Reason for exclusion: Narrative review, no data

Atienza VC. Epidemiology of rabies in animals in the Philippines. In: Rabies control in Asia, Dodet B, Meslin FX, editors, 2001.
Reason for exclusion: Results of microbiological survey of canine samples
Aye Y. Myanmar - Human aspects of rabies prevention and control. In: Rabies control in Asia, Dodet B, Meslin FX, editors 1997.
Reason for exclusion: Countiry report, descriptive epidemiology of rabies

Barboza P, Tarantola A, Lassel L, Mollet T, Quatresous I, Paquet C. Viroses émergentes en Asie du Sud-Est et dans le Pacifique. Médecine Et Maladies Infectieuses. 2008;38(10):513-23.
Reason for exclusion: Narrative review, no data

Beran. Ecology of dogs in the Central Philippines in relation to rabies control efforts. Comparative Immunology, Microbiology and Infectious Diseases. 1982.5: 265-270.
Reason for exclusion: Survey of dog population prior to rabies control program, no outcome data

Beran GW, Frith M. Domestic animal rabies control: an overview. Reviews Of Infectious Diseases. 1988;10 Suppl 4:S672-S7.
Reason for exclusion: Development of a model using a city in Ecuador

Bingham J. Rabies on Flores Island, Indonesia: is eradication possible in the near future? Dodet B, Meslin FX, editors2001.
Reason for exclusion: Narrative review, no data

Bögel K and Meslin FX. Economics of human and canine rabies elimination: guidelines for program orientation. Bulletin Of The World Health Organization. 1990;68(3):281-91.
Reason for exclusion: Model-based cost-effectiveness study

Burki T. The global fight against rabies. Lancet. 2008; 372(9644):1135-6.
Reason for exclusion: News article

Cabello C C, Cabello C F. [Zoonoses with wildlife reservoirs: a threat to public health and the economy]. Revista Médica De Chile. 2008; 136(3):385-93.

Reason for exclusion: Narrative review, no data

Camba RA. Philippines - Update of rabies control program. In: Rabies control in Asia, Dodet B, Meslin FX, editors, 1997.
Reason for exclusion: Narrative review of rabies contol program

Childs JE, Robinson LE, Sadek R, Madden A, Miranda ME, Miranda NL. Density estimates of rural dog populations and an assessment of marking methods during a rabies vaccination campaign in the Philippines. Preventive Veterinary Medicine. 1998;33(1–4):207-18.
Reason for exclusion: Tracking methodology paper

Cleaveland S, Kaare M, Knobel D, Laurenson MK. Canine vaccination--providing broader benefits for disease control. Veterinary Microbiology. 2006;117(1):43-50.
Reason for exclusion: Narrative review, no data

Cleaveland S, Meslin FX, Breiman R. Dogs can play useful role as sentinel hosts for disease. Nature. 2006;440(7084):605-.
Reason for exclusion: Letter, no data

Clements ACA, Pfeiffer DU. Emerging viral zoonoses: Frameworks for spatial and spatiotemporal risk assessment and resource planning. The Veterinary Journal. 2009;182(1):21-30.
Reason for exclusion: Narrative review, no data

Coker RJ, Hunter BM, Rudge JW, Liverani M, Hanvoravongchai P. Health in Southeast Asia 3: Emerging infectious diseases in Southeast Asia: regional challenges to control. The Lancet. 2011;377(9765):599-609.
Reason for exclusion: Narrative review, no data

Coleman PG, Fevre, EM, Cleaveland, S. Estimating the public health impact of rabies. Emerging Infectious Diseases. 2004;10:140-2.
Reason for exclusion: Burden of disease using DALY

Dalla Villa P, Kahn S, Stuardo L, Iannetti L, Di Nardo A, Serpell JA. Free-roaming dog control among OIE-member countries. Preventive Veterinary Medicine. 2010;97(1):58-63.
Reason for exclusion: Description of activities but no data on outcomes

Dang Vung N. Animal-Human Health Interface and community based surveillance in Viet Nam-a strategy under Mekong Basin Disease Surveillance Cooperation (MBDS). BMC Proceedings. 2011;5 (Suppl 1):P113.
Reason for exclusion: Poster presentation at conference, only abstract available

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Reason for exclusion: Narrative review, no data

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Reason for exclusion: Review article, no data

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Dengue – articles

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Reason for exclusion: no evaluation data

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: evaluation of community healthworker program but not focused on dengue

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Reason for exclusion: narrative review article, no original data

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Reason for exclusion: Model fitting exercise

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Reason for exclusion: No actual before and after data given

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Laboratory study

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Reason for exclusion: descriptive study, no intervention

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: cross-sectional KAP survey, no intervention
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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: outbreak report

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Reason for exclusion: editorial, no data

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Reason for exclusion: theoretical model for developing interventions, no evaluation data

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Reason for exclusion: narrative review article, no original data

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Reason for exclusion: Brazil, not SE Asia

Mahilum MM, Ludwig M, Madon MB, Becker N. Evaluation of the present dengue situation and control strategies against Aedes aegypti in Cebu City, Philippines. Journal Of Vector Ecology: Journal Of The Society For Vector Ecology. 2005;30(2):277-83.
Reason for exclusion: Only before/after data is for field trial, community study is cross-sectional data

Moodie R, Borthwick C, Galbally R. Health promotion in South-East Asia: Indonesia, DPR Korea, Thailand, the Maldives and Myanmar.* (*This paper was commissioned as part of a WHO-sponsored initiative utilizing a common presentation framework.). Health Promotion International 2000;15:249-.
Reason for exclusion: description of infrastructure for health promotion, no evaluation data

Nagao Y, Thavara U, Chitnumsup P, Tawatsin A, Chansang C, Campbell-Lendrum D. Climatic and social risk factors for Aedes infestation in rural Thailand. Tropical Medicine & International Health: TM & IH 2003;8:650-9.
Reason for exclusion: cross-sectional survey of risk factor, no intervention

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: cross-sectional survey of vector control prevalence, no intervention. Not a before/after study, more a feasibility study

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Reason for exclusion: clinical outbreak report

Ole S. Microbial control in Southeast Asia. Journal of Invertebrate Pathology 2007;95:168-74.

Reason for exclusion: narrative review article, no original data

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Reason for exclusion: cross-sectional KAP survey, no intervention

Ooi E-E, Goh K-T, Gubler DJ. Dengue prevention and 35 years of vector control in Singapore. Emerging Infectious Diseases 2006;12:887-93.

Reason for exclusion: description of control activities but no evaluation data

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Reason for exclusion: Mexico, not SE Asia

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Reason for exclusion: letter, no data

Phuanukoonnon S, Mueller I and Bryan JH. Effectiveness of dengue control practices in household water containers in northeast Thailand. Tropical Medicine and International Health. 2005;10:755-63.

Cross-sectional survey

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: No before/after data, surveillance not carried out prior to interventions

Pylypa J. Local perceptions of dengue fever in northeast Thailand and their implications for adherence to prevention campaigns. Anthropology & Medicine 2009;16:73-83.
Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: narrative review article, no original data

Seleena P, Lee HL, Chiang YF. Thermal application of Bacillus thuringiensis serovar israelensis for dengue vector control. Journal Of Vector Ecology: Journal Of The Society For Vector Ecology 2001;26:110-3.
Reason for exclusion: field trial of intervention, not community based

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Reason for exclusion: No baseline data

Soedarmo SP. The epidemiology, prevention and control of dengue hemorrhagic fever in Indonesia. Gaoxiong Yi Xue Ke Xue Za Zhi = The Kaohsiung Journal Of Medical Sciences 1994;10 Suppl:S109-S12.
Reason for exclusion: abstract only

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Reason for exclusion: clinical review, no intervention

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Reason for exclusion: narrative review article, no original data

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Reason for exclusion: Field trial – no community component

Susan B R. Paradigms lost: Toward a new understanding of community participation in health programs. Acta Tropica 1996;61:79-92.
Reason for exclusion: review of community participation, no dengue intervention

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Reason for exclusion: narrative review article, no original data

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: review of community participation, no dengue intervention

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Reason for exclusion: cross-sectional KAP survey, no intervention

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Reason for exclusion: narrative review article, no original data

Thomas SJ, Strickman D, Vaughn DW. Dengue epidemiology: virus epidemiology, ecology, and emergence. Advances In Virus Research 2003;61:235-89.
Reason for exclusion: narrative review article, no original data

Thompson F, Caltabiano ML. The Health Belief Model and dengue fever preventative behaviours: a pilot program. International Journal of Health Promotion & Education 2010;48:9-19.
Reason for exclusion: Australia, not SE Asia

Tien NTK, Ha DQ, Tien TK, Quang LC. Predictive indicators for forecasting epidemic of dengue/dengue haemorrhagic fever through epidemiological, virological and entomological surveillance. Dengue bulletin. 1999;23.
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Reason for exclusion: Library unable to locate report

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Reason for exclusion: Review of 2003 global events

Zhou Z-X, Jiang C-Q. [Effect of environment and occupational hygiene factors of hospital infection on SARS outbreak]. Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi = Zhonghua Laodong Weisheng Zhiyebing Zazhi = Chinese Journal Of Industrial Hygiene And Occupational Diseases. 2004;22(4):261-3.
Reason for exclusion: Hospital risk factors, China

SARS – systematic reviews

Gupta AG, Moyer CA, Stern DT. The economic impact of quarantine: SARS in Toronto as a case study (Structured abstract). Centre for Reviews and Dissemination. 2005
Reason for exclusion: Setting is Toronto

Fung IC, Cairncross S. How often do you wash your hands? a review of studies of hand-washing practices in the community during and after the SARS outbreak in 2003. International Journal of Environmental Health Research. 2007;17(3):161-83.
Reason for exclusion: Review of studies of hand-washing practice.

Fung IC-H, Cairncross S. Effectiveness of handwashing in preventing SARS: a review. Tropical Medicine & International Health: TM & IH. 2006;11(11):1749-58.
Reason for exclusion: Settings mainly China, Hong Kong and North America. Single study from Singapore looked at preventing nosocomial infection

Jefferson T, Foxlee R, Del Mar C, Dooley L, Ferroni E, Hewak B, *et al.* Interventions for the interruption or reduction of the spread of respiratory viruses. Cochrane Database Of Systematic Reviews (Online). 2007(4):CD006207.
Reason for exclusion: Settings for included studies are China, Hong Kong, Taiwan and North America. Focus on nosocomial transmission

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Reason for exclusion: Settings for included studies are China, Hong Kong, Taiwan and North America. Focus on nosocomial transmission

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Reason for exclusion: Pharmaceutical interventions

Liu J P, Manheimer E, Shi Y. Systematic review and meta-analysis on the integrative traditional Chinese and Western medicine in treating SARS (Provisional abstract). Centre for Reviews and Dissemination. 2005
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detection of severe acute respiratory syndrome coronavirus (Structured abstract). Centre for Reviews and Dissemination. 2004
Reason for exclusion: No intervention, evaluation of laboratory assay

Stockman LJ, Bellamy L, Garner P. SARS: systematic review of treatment effects (Structured abstract). Centre for Reviews and Dissemination. 2006
Reason for exclusion: Pharmaceutical interventions

Avian Influenza – articles

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Reason for exclusion: Editorial

Avian influenza, Thailand. Weekly Epidemiological Record. 2004;79(42):377-8.
Reason for exclusion: Update of Thai 2004 outbreak. No data

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Reason for exclusion: Outbreak update and comment on transmission

Avian influenza -- situation in Viet Nam at of 18 August 2004. Weekly Epidemiological Record. 2004;79(34):309-.
Reason for exclusion: Outbreak update

Avian influenza A(H5N1) in humans and poultry, Viet Nam. Weekly Epidemiological Record. 2004;79(3):13-4.
Reason for exclusion: Outbreak update

Current concepts: avian influenza A (H5N1) infection in humans. New England Journal of Medicine. 2005;353(13):1374.
Review. No data

Best defence against avian flu is to fight the virus in Asia. Bulletin Of The World Health Organization. 2005;83(12):887-9.
Reason for exclusion: Discusses issues around control, but no data

Bird Flu; Cost-effective disease prevention includes closing or regulating wildlife markets. Virus Weekly. 2007(15316424):14-.
Reason for exclusion: News article

Alders RG, Bagnol B, Brum E, Lubis AS, Young MP. Continuing education in the prevention and control of HPAI: a case study on Indonesia. 2009; 65:529-31.
Reason for exclusion: Discussion paper, no intervention

Amonsin, A., C. Choatrakol, *et al.* (2008). Influenza virus (H5N1) in live bird markets and food markets, Thailand. Emerging Infectious Diseases 14(11): 1739-1742.
Reason for exclusion: Sero-surveillance program 2006-7; no intervention

Areechokchai, D., C. Jiraphongsa, *et al.* (2006). Investigation of avian influenza (H5N1) outbreak in humans--Thailand, 2004. MMWR. Morbidity And Mortality Weekly Report 55 Suppl 1: 3-6.
Reason for exclusion: Matched case-control study to study risk factors of infection

Auewarakul, P., W. Hanchaoworakul, *et al.* (2008). Institutional responses to avian influenza in Thailand: control of outbreaks in poultry and preparedness in the case of human-to-human transmission. Anthropology & Medicine 15(1): 61-67.

Reason for exclusion: All Thai government-driven initiatives

Beltran-Alcrudo D, Bunn DA, Sandrock CE, Cardona CJ. Avian flu school: a training approach to prepare for H5N1 highly pathogenic avian influenza. Public Health Reports (Washington, DC: 1974). 2008; 123(3):323-32.

Reason for exclusion: Not Southeast Asia focused

Bhatia R, Narain JP. Preventing avian influenza in humans: the role of simple public health interventions. The Southeast Asian Journal of Tropical Medicine and Public Health. 2006; 37 (6): 1229-36.

Reason for exclusion: Narrative review, no data.

Buranathai, C, Amonsin A, *et al.* (2007). "Surveillance activities and molecular analysis of H5N1 highly pathogenic avian influenza viruses from Thailand, 2004-2005." Avian Diseases 51(1 Suppl): 194-200.

Reason for exclusion: Clinical and laboratory surveillance following outbreak. Not community-based

Capua I and Alexander DJ. The challenge of avian influenza to the veterinary community. Avian Pathology. 2006; 35(3):189-205.

Reason for exclusion: Narrative review, no data

Cardona CJ, Byarugaba D, Mbuthia P, Aning G, Sourou S, Bunn DA *et al.* Detection and prevention of highly pathogenic avian influenza in communities with high poultry disease burdens. Avian Diseases. 2010;54(1 Suppl):754-6.

Reason for exclusion: Setting Africa, focuses on Newcastle disease

Chantong, W. and J. B. Kaneene (2011). "Poultry raising systems and highly pathogenic avian influenza outbreaks in Thailand: the situation, associations, and impacts." The Southeast Asian Journal Of Tropical Medicine And Public Health 42(3): 596-608.

Reason for exclusion: Review of structure of poultry raising systems

Chuengsatiansup, K. (2008). "Ethnography of epidemiologic transition: avian flu, global health politics and agro-industrial capitalism in Thailand." Anthropology & Medicine 15(1): 53-59.

Reason for exclusion: Not at community level

Chiu, D. An informatics and epidemiological evaluation of infectious disease surveillance ad reporting practices in Thailand: a case study ofSuphanburi province and Avian Influenza. AMIA 2008 Symposium Proceedings page 904.

Reason for exclusion: Surveillance evaluation of national government-established systems

Chunsuttiwat, S. (2008). "Response to avian influenza and preparedness for pandemic influenza: Thailand's experience." Respirology (Carlton, Vic.) 13 Suppl 1: S36-S40.

Reason for exclusion: Prevention programs, pandemic preparedness. Not at community level

Chutinimitkul S, Payungporn S, Chieochansin T, Suwannakarn K, Theamboonlers A, Poovorawan Y. The spread of avian influenza H5N1 virus; a pandemic threat to mankind. Journal of Medical Association of Thailand= Chotmaihet Thangphaet. 2006;89 Suppl 3:S218-S33.

Reason for exclusion: Narrative review, interventions discussed are pharmaceutical only

Clague B, Chamany S. A household survey to assess the burden of influenza in rural Thailand. Southeast Asian Journal of Tropical Medicine and Public Health. 2006;37(3):488-93.

Reason for exclusion: No intervention

Cristalli, A. and I. Capua (2007). "Practical problems in controlling H5N1 high pathogenicity avian influenza at village level in Viet Nam and introduction of biosecurity measures." Avian Diseases 51(1 Suppl): 461-462.

Reason for exclusion: Comment on inclusion of backyard flocks in preventative measures

Dauphin, G., K. Hamilton, *et al.* (2010). Main achievements of the World Organisation for Animal Health/United Nations Food and Agriculture Organization network on animal influenza. Avian Diseases 54(1 Suppl): 380-383.

Reason for exclusion: Overview of OFFLU

de Sa, J., S. Mounier-Jack, *et al.* (2010). Responding to pandemic influenza in Cambodia and Lao PDR: challenges in moving from strategy to operation. The Southeast Asian Journal Of Tropical Medicine And Public Health 41(5): 1104-1115.
Reason for exclusion: Review of government and international health organisation-driven initiatives

Eagles, D., E. S. Siregar, *et al.* (2009). H5N1 highly pathogenic avian influenza in Southeast Asia. Revue Scientifique Et Technique (International Office Of Epizootics) 28(1): 341-348.
Reason for exclusion: Narrative review.

Ellis TM, Leung CYHC, Chow MKW, Bissett LA, Wong W, Guan Y *et al.* Vaccination of chickens against H5N1 avian influenza in the face of an outbreak interrupts virus transmission. Avian Pathology: Journal of the WVPA/ 2004;33(4):405-12.
Reason for exclusion: Vaccine trial in field setting. Not community based, Hong Kong study

Farnsworth, M. L., C. Hamilton-West, *et al.* (2010). Comparing national and global data collection systems for reporting, outbreaks of H5N1 HPAI. Preventive Veterinary Medicine 95(3-4): 175-185.
Reason for exclusion: Evaluation of EMPRES (FAO) surveillance data. Not community focused

Farnsworth M, Fitchett S, Hidayat MM, Lockhart C, Hamilton-West C *et al.* Metapopulation dynamics and determinants of H5N1 highly pathogenic avian influenza outbreaks in Indonesian poultry. Preventative Veterinary Medicine, 2011;102:206-217.
Reason for exclusion: Model-based analysis to assess probability of HPAI occurrence

Figuie M, Fournier T. Global Health risks and National Policies. Avian Influenza Risk Management in Viet Nam. Review of Agricultural and Environmental Studies/Revue d'Etudes en Agriculture et Environnement. 2010;91(3):327-43.
Reason for exclusion: Narrative review, no intervention

Fleming D. Influenza pandemics and avian flu. BMJ: British Medical Journal (International Edition). 2005; 331(7524):1066-9.
Reason for exclusion: Narrative, very general

Hampson AW, Mackenzie JS. The influenza viruses. The Medical Journal of Australia. 2006; 185(10 Suppl):S39-S43.
Reason for exclusion: General, no intervention

Hanvoravongchai, P., W. Adisasmito, *et al.* (2010). "Pandemic influenza preparedness and health systems challenges in Asia: results from rapid analyses in 6 Asian countries." BMC Public Health 10: 322-322.
Reason for exclusion: Analysis of pandemic preparedness programs

Häsler B, Howe KS, Stärk KDC. Conceptualising the technical relationship of animal disease surveillance to intervention and mitigation as a basis for economic analysis. BMC Health Services Research. 2011; 11:225-
Reason for exclusion: AI used as example to illustrate framework

Henning, J., D. U. Pfeiffer, *et al.* (2009). "Risk factors and characteristics of H5N1 Highly Pathogenic Avian Influenza (HPAI) post-vaccination outbreaks." Veterinary Research 40(3): 15-15.
Reason for exclusion: Risk factor analysis, but no intervention

Henning, K. A., J. Henning, *et al.* (2009). "Farm- and flock-level risk factors associated with Highly Pathogenic Avian Influenza outbreaks on small holder duck and chicken farms in the Mekong Delta of Viet Nam." Preventive Veterinary Medicine 91(2-4): 179-188.
Reason for exclusion: Risk factor analysis

Ifft J, Roland-Holst D, Zilberman D. Production and Risk Prevention Response of Free Range Chicken Producers in Viet Nam to Highly Pathogenic Avian Influenza Outbreaks. American Journal of Agricultural Economics. 2011; 93(2):490-7.
Reason for exclusion: Behavioural analysis, model-based

Imperato PJ. The Growing Challenge of Avian Influenza Journal of Community Health. 2005;30(5):327-30.
Reason for exclusion: Surveillance in Asia. Very general

Indriani, R., G. Samaan, *et al.* (2010). "Environmental sampling for avian influenza virus A (H5N1) in live-bird markets, Indonesia." Emerging Infectious Diseases 16(12): 1889-1895.
Reason for exclusion: Survey of markets, risk and protective factors

Jost CC. Immediate assistance for strengthening community-based early warning and early reaction to avian influenza in Indonesia. In 5th Quarter Report (October – December 2006) and Chief Technical Advisor End of Contract Report (1 February 2007). Tufts University School of Veterinary Medicine International Program for the Food and Agriculture Organisation of the United Nations, Rome.
Reason for exclusion: Project proposal, no data

Juckett G. Avian influenza: preparing for a pandemic. American Family Physician. 2006;74(5):783-90.
Reason for exclusion: Narrative review

Kelly TR, Hawkins MG, Sandrock CE, Boyce WM. A review of highly pathogenic avian influenza in birds, with an emphasis on Asian H5N1 and recommendations for prevention and control. Journal of Avian Medicine and Surgery. 2008;22(1):1-16.
Reason for exclusion: Narrative review, US focused

Khanna, M., P. Kumar, *et al.* (2008). "Emerging influenza virus: A global threat." Journal of Biosciences 33(4): 475-482.
Reason for exclusion: Review of epidemiology

Kimball AM, Moore M, French HM, Arima Y, Ungchusak K, Wilbulpolprasert S *et al.* Regional infectious disease surveillance networks and their potential to facilitate the implementation of the international health regulations. Medical Clinic of North America. 2008;92(6):1459-71.
Reason for exclusion: Discusses Mekong Basin Disease Surveillance Network, but no data

Kitphati R, Apisarnthanarak A, Chittaganpitch,M, Tawatsupha P, Auwanit W *et al.* A nationally coordinated laboratory system for human avian influenza A (H5N1) in Thailand: program design, analysis and evaluation. Clinical Infectious Diseases, 2008;46:1394-1400.
Reason for exclusion: Review of government and international health organisation-driven initiatives

Kleinman, A. M., B. R. Bloom, *et al.* (2008). "Asian flus in ethnographic and political context: a biosocial approach." Anthropology & Medicine 15(1): 1-5.
Reason for exclusion: Analysis of local context. No intervention

Koh, G., T. Wong, *et al.* (2008). "Avian Influenza: a global threat needing a global solution." Asia Pacific Family Medicine 7(1): 5-5.
Reason for exclusion: Very general review

Kruy, S. L., Y. Buisson, *et al.* (2008). "[Asia: avian influenza H5N1]." Bulletin De La Société De Pathologie Exotique (1990) 101(3): 238-242.
Reason for exclusion: Narrative review

Kuiken T, Leighton FA, Fouchier RAM, LeDuc JW, Peiris JSM *et al.* Pathogen surveillance in animals. Science, 2005; 309:1680-81.
Reason for exclusion: Public health policy forum.

Lazzari S and Stohr K. Avian influenza and influenza pandemics. Bulletin of the World Health Organization. 2004;82(4)242-242A.
Reason for exclusion: Editorial

Leibler JH, Otte J, Roland-Holst D, Pfeiffer DU, Soares-Magalhaes R, Rushton J *et al.* Industrial Food Animal Production and Global Health Risks: Exploring the Ecosystems and Economics of Avian Influenza. Ecohealth. 2009;6(1):58-70.
Reason for exclusion: Narrative review

Leong, H. K., C. S. Goh, *et al.* Prevention and control of avian influenza in Singapore. Annals Of The Academy Of Medicine, Singapore. 2008; 37(6): 504-509.
Reason for exclusion: Review of government driven interventions

Ligon BL. Avian influenza virus H5N1: a review of its history and information regarding its potential to cause the next pandemic. Seminars in Pediatric Infectious Diseases. 2005;16(4):326-35.
Reason for exclusion: Narrative review, no intervention

Longini, I. M., Jr., A. Nizam, *et al.* (2005). "Containing pandemic influenza at the source." Science (New York, N.Y.) 309(5737): 1083-1087.
Reason for exclusion: Model to estimate effectiveness of quarantine, anti-virals

Loth, L., M. Gilbert, *et al.* (2011). Identifying risk factors of highly pathogenic avian influenza (H5N1 subtype) in Indonesia. Preventive Veterinary Medicine 102(1): 50-58.
Reason for exclusion: Identification of risk factors for presence of HPAI; no intervention

Lubroth J. Control strategies for highly pathogenic avian influenza: a global perspective. Developments In Biologicals. 2007;130:13-21.
Reason for exclusion: Prevention programs for detection and control of HPAI. First world focused

Lugnér AK, Postma MJ. Mitigation of pandemic influenza: a review of cost-effectiveness studies. Expert Review of Pharmacoeconomics & Outcomes Research. 2009;9(6):547-58.
Reason for exclusion: Model-based cost-effectiveness studies

Marris E. Despite doubts, containment plans for pandemic take shape. Nature Medicine. 2006;12(5):485-
Reason for exclusion: Describes WHO draft containment plan March 2004

McLeod A. Economics of avian influenza management and control in a world with competing agendas. Avian Diseases. 2010;54(1 Suppl):374-9.
Reason for exclusion: Review of economic issues, no data

Moore M, Dausey DJ. Response to the 2009-H1N1 influenza pandemic in the Mekong Basin: surveys of country health leaders. BMC Research Notes. 2011;4(1):361.
Reason for exclusion: Swine influenza epidemic

Morris SK. H5N1 avian influenza, Kampot Province, Cambodia. Emerging Infectious Diseases. 2006;12(1):170-1.
Letter
Morse, SS. (2007). Global Infectious Disease Surveillance And Health Intelligence. Health Affairs 26(4): 1069-1077.
Reason for exclusion: Narrative review

Nicholson KG, Wood JM, Zambon M. Influenza. The Lancet. 2003;362(9397):1733-45.
Reason for exclusion: Narrative review

Normile D. Avian influenza. WHO proposes plan to stop pandemic in its tracks. Science (New York, NY). 2006;311(5759):315-6.
Reason for exclusion: Magazine article, no data

Normile D. Indonesia Taps Village Wisdom to Fight Bird Flu. Science. 2007;315(5808):30-3.
Reason for exclusion: Magazine article, no data

Normile, D. and M. Enserink (2005). "Lapses Worry Bird Flu Experts." Science 308(5730): 1849-1849,1851.
Reason for exclusion: Magazine article, no data

Normile D. Avian influenza. Warning of H5N1 resurgence surprises community. Science (New York, NY). 2011;333(6048):1369-.

Reason for exclusion: Magazine article, no data

Olsen S, Ungchusak K, Birmingham M, Bresee, J, Dowell SF, Chunsuttiwat S. Surveillance for avian influenza in human beings in Thailand. The Lancet Infectious Diseases, 2006; 6:757-8.
Reason for exclusion: Short commentary

Oshitani H. Potential benefits and limitations of various strategies to mitigate the impact of an influenza pandemic. Journal of Infection And Chemotherapy: Official Journal Of The Japan Society Of Chemotherapy. 2006;12(4):167-71.
Reason for exclusion: Narrative review

Otto, J. L., P. Baliga, *et al.* Training initiatives within the AFHSC-Global Emerging Infections Surveillance and Response System: support for IHR (2005). BMC Public Health 2011;11(Suppl 2): S5.
Reason for exclusion: Not community-based

Padmawati S, Nichter M. Community response to avian flu in Central Java, Indonesia. Anthropology & Medicine. 2008;15(1):31-51.
Reason for exclusion: Overview of poultry system, survey of perceptions of AI, no intervention

Parry, J. (2004). "Mortality from avian flu is higher than in previous outbreak." British Medical Journal 328(7436): 368-368.
Reason for exclusion: News article, no data

Parry, J. (2004). "WHO investigates possible human to human transmission of avian flu." British Medical Journal 328(7435): 308-308.
Reason for exclusion: Article, no data

Parry, J. (2004). "WHO confirms avian flu outbreak in Hanoi." British Medical Journal 328(7432): 123-123.
Reason for exclusion: News article, no data

Parry, J. Ten years of fighting bird flu. Bulletin of the World Health Organization. 2007;85:3-4.
Reason for exclusion: News article

Paul M, Wongnarkpet S, Gasqui P, Poolkhet C, Thongratsakul S *et al.* Risk factors for highly pathogenic avian influenza (HPAI) H5N1 infection in backyard chicken farms, Thailand. Acta Tropica. 2011;118:209-16.
Reason for exclusion: Risk factor identification through case control study. No intervention

Pfeiffer DU, Minh PQ, Martin V, Epprecht M, Otte MJ. An analysis of the spatial and temporal patterns of highly pathogenic avian influenza occurrence in Viet Nam using national surveillance data. Veterinary Journal (London, England: 1997). 2007;174(2):302-9.
Reason for exclusion: Surveillance data to inform outbreak risk

Pitsuwan S. Challenges in infection in ASEAN. The Lancet. 2011;377(9766):619-21.
Reason for exclusion: Government driven initiatives

Rushton J, Viscarra R, Guerne Bleich E, McLeod A. Impact of avian influenza outbreaks in the poultry sectors of five South East Asian countries (Cambodia, Indonesia, Lao PDR, Thailand, Viet Nam): outbreak costs, responses and potential long term control. World's Poultry Sci J. 2005; 61:491-514.
Reason for exclusion: Narrative review, no data on community interventions

Samaan G, Gultom A, Indriani R, Lokuge K, Kelly PM. Critical control points for avian influenza A H5N1 in live bird markets in low resource settings. Preventive Veterinary Medicine. 2011;100(1):71-8.
Reason for exclusion: Cross-sectional and KAP surveys, microbiological survey

Sambhara S, Poland GA. H5N1 Avian influenza: preventive and therapeutic strategies against a pandemic. Annual Review of Medicine. 2010;61:187-98.
Reason for exclusion: Narrative review, focusing on anti-virals and vaccines

Sims LD. Lessons learned from Asian H5N1 outbreak control. Avian Diseases. 2007;51(1 Suppl):174-81.
Reason for exclusion: Narrative review, no data

Soares Magalhães RJ, Ortiz-Pelaez A, Thi KLL, Dinh QH, Otte J, Pfeiffer DU. Associations between attributes of live poultry trade and HPAI H5N1 outbreaks: a descriptive and network analysis study in northern Viet Nam. BMC Veterinary Research. 2010;6:10-
Reason for exclusion: Cross-sectional survey, social network analysis of poultry traders. No intervention

Soares Magalhães RJ, Pfeiffer DU, Otte J. Evaluating the control of HPAIV H5N1 in Viet Nam: virus transmission within infected flocks reported before and after vaccination. BMC Veterinary Research. 2010;6:31-.
Reason for exclusion: Model-based study to assess vaccination and depopulation measures

Stone R. Avian influenza. Combating the bird flu menace, down on the farm. Science (New York, NY). 2006;311(5763):944-6.
Reason for exclusion: News article

Subbarao K. Evaluation of novel influenza A viruses and their pandemic potential. Pediatric Annals. 2000;29(11):712-8.
Reason for exclusion: Narrative review

Swayne DE, Suarez DL. Highly pathogenic avian influenza. Revue Scientifique Et Technique (International Office Of Epizootics). 2000;19(2):463-82.
Reason for exclusion: Narrative review

Thomas N. The Regionalization of Avian Influenza in East Asia: Responding to the Next Pandemic(?). Asian Survey. 2006;46(6):917-36.
Reason for exclusion: Overview of H5N1 in Asia, but no data

Thorson A, Petzold M, Nguyen TKC, Ekdahl K. Is exposure to sick or dead poultry associated with flulike illness?: a population-based study from a rural area in Viet Nam with outbreaks of highly pathogenic avian influenza. Archives Of Internal Medicine. 2006;166(1):119-23.
Reason for exclusion: Risk factor analysis, no intervention

Tiensin T, Chaitaweesub P, Songserm T, Chaisingh A, Hoonsuwan W, Buranathai C, *et al.* Highly pathogenic avian influenza H5N1, Thailand, 2004. Emerging Infectious Diseases. 2005;11(11):1664-72.
Reason for exclusion: Control measures all government-driven

Tiensin T, Nielen M, Songserm T, Kalpravidh W, Chaitaweesub P, Amonsin A, *et al.* Geographic and temporal distribution of highly pathogenic avian influenza A virus (H5N1) in Thailand, 2004-2005: an overview. Avian Diseases. 2007;51(1 Suppl):182-8.
Reason for exclusion: Thai outbreak, 2004. All government driven control measures

Trevennec K, Chevalier V, Grosbois V, Garcia JM, Thu HH, Berthouly–Salazar C, *et al.* Looking for avian influenza in remote areas. A case study in Northern Viet Nam. Acta Tropica. 2011;120(3):160-6.
Reason for exclusion: Serosurvey, interviews, but no intervention; risk factors for infection

Van Kerkhove MD, Vong S, Guitian J, Holl D, Mangtani P, San S, *et al.* Poultry movement networks in Cambodia: implications for surveillance and control of highly pathogenic avian influenza (HPAI/H5N1). Vaccine. 2009;27(45):6345-52.
Reason for exclusion: Cross-sectional survey of trading practices, no intervention

Watts J. Viet Nam needs cash to stave off future outbreaks of bird flu. The Lancet. 2005;365(9473):1759-60.
Reason for exclusion: Article, no data

Williams JR, Chen P-Y, Cho CT, Chin TDY. Influenza: prospect for prevention and control. The Kaohsiung Journal of Medical Sciences. 2002;18(9):421-34.
Reason for exclusion: Narrative review, no data

Yee KS, Carpenter TE, Cardona CJ. Epidemiology of H5N1 avian influenza. Comparative Immunology, Microbiology and Infectious Diseases. 2009;32(4):325-40.
Reason for exclusion: Narrative review, no data

Yupiana Y, de Vlas SJ, Adnan NM, Richardus JH. Risk factors of poultry outbreaks and human cases of H5N1 avian influenza virus infection in West Java Province, Indonesia. International Journal Of Infectious Diseases: IJID: Official Publication Of The International Society For Infectious Diseases. 2010;14(9):e800-e5.
Reason for exclusion: Risk factor analysis, no intervention

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Manzoli L, Salanti G, De Vito G, Boccia A, Ioannidis JP, Villari P. Immunogenicity and adverse events of avian influenza A H5N1 vaccine in healthy adults: multiple-treatments meta-analysis (Structured abstract). Centre for Reviews and Dissemination. 2009
Reason for exclusion: Pharmaceutical intervention

Appendix VI – Joanna Briggs Institute levels of evidence

Taken from the Joanna Briggs Institute – Reviewers' Manual 2011 Edition: Appendix VI – JBI Levels of evidence p. 150

Levels of Evidence	Feasibility F (1-4)	Appropriateness A (1-4)	Meaningfulness M (1-4)	Effectiveness E (1-4)	Economic Evidence EE (1-4)
1	Metasynthesis of research with unequivocal synthesised findings	Metasynthesis of research with unequivocal synthesised findings	Metasynthesis of research with unequivocal synthesised findings	Meta-analysis (with homogeneity) of experimental studies (eg RCT with concealed randomisation) OR One or more large experimental studies with narrow confidence intervals	Metasynthesis (with homogeneity) of evaluations of important alternative interventions comparing all clinically relevant outcomes against appropriate cost measurement, and including a clinically sensible sensitivity analysis
2	Metasynthesis of research with credible synthesised findings	Metasynthesis of research with credible synthesised findings	Metasynthesis of research with credible synthesised findings	One or more smaller RCTs with wider confidence intervals OR Quasi-experimental studies (without randomisation)	Evaluations of important alternative interventions comparing all clinically relevant outcomes against appropriate cost measurement, and including a clinically sensible sensitivity analysis
3	a. Metasynthesis of text/opinion with credible synthesised findings b. One or more single research studies of high quality	a. Metasynthesis of text/opinion with credible synthesised findings b. One or more single research studies of high quality	a. Metasynthesis of text/opinion with credible synthesised findings b. One or more single research studies of high quality	a. Cohort studies (with control group) b. Case-controled c. Observational studies (without control group)	Evaluations of important alternative interventions comparing a limited number of appropriate cost measurement, without a clinically sensible sensitivity analysis
4	Expert opinion	Expert opinion	Expert opinion	Expert opinion, or physiology bench research, or consensus	Expert opinion, or based on economic theory

Appendix VII – Extended meta-analysis report

Our Bayesian meta-analysis adjusts for repeated results from the same study. Many studies in this field had multiple results, for example results from two or more villages, or from the same village at two or more times. One option is to combine the results across villages, by summing the total number of incidences and samples, for example summing across all control villages and across all intervention villages. This would give one result per study, but could be problematic if there are strong reasons against combining villages (e.g., villages in high and low risk areas). Our meta-analyses use the multiple individual results from each study, and adjusts for repeated results by using a random study effect.

There were two types of dependent data:

1. Counts of the number of successes and failures, for example the number of containers that tested positive for mosquitoes and the total number of containers tested. We modelled this data using a binomial distribution.
2. Failure rates, for example the number of containers that tested positive for mosquitoes per 100 sampled. These data often had no information on the denominator. We modelled this data using a Poisson distribution.

The hierarchical set of equations and priors for the meta-analysis of binomial data are:

$$\begin{aligned}
r^C_{i,j} &\sim \text{Binomial}(p^C_{i,j}, n^C_{i,j}), \qquad i = 1, \dots, n,\ j = 1, \dots, m_i,\\
r^I_{i,j} &\sim \text{Binomial}(p^I_{i,j}, n^I_{i,j}),\\
\text{logit}(p^C_{i,j}) &= \mu_{i,j},\\
\text{logit}(p^I_{i,j}) &= \mu_{i,j} + \delta_{i,j},\\
\mu_{i,j} &\sim \text{Normal}(0, 10^5),\\
\delta_{i,j} &\sim \text{Normal}(\theta_i, \sigma^2_\delta),\\
\theta_i &\sim \text{Normal}(d, \sigma^2_\theta),\\
d &\sim \text{Normal}(0, 10^5),\\
\sigma_\delta &\sim \text{Uniform}(0, 10),\\
\sigma_\theta &\sim \text{Uniform}(0, 10),
\end{aligned}$$

where r^C is the number of positive tests from n^C samples for a control result, and r^I and n^I are the numbers for an intervention result. The index i represents each study, and the index j represents a result within a study. There are n studies and m_i results in study i. The probabilities for the control and intervention results are modelled using a logit link. The true effect $\delta_{i,j}$ for each result (on a log-odds scale) is drawn from a Normal distribution centred on the study effect, θ_i. In the next level of the hierarchy this study effect is drawn from a Normal distribution whose mean, d, is the summary log odds ratio. The standard deviations of the Normal distributions for results (σ_δ) and studies (σ_θ) are drawn from a Uniform distribution. The upper limit of 10 for this normal distribution may seem small, but this covers a wide potential for the between-study and between-result variability.

The above set of equations are akin to a generalised linear mixed model with a random intercept for each study [1].

The hierarchical set of equations and priors for the meta-analysis of rates are (using the same notation as above):

$$\begin{aligned}
r^C_{i,j} &\sim \text{Poisson}(\mu^C_{i,j}), \qquad i = 1, \dots, n,\ j = 1, \dots, m_i,\\
r^I_{i,j} &\sim \text{Poisson}(\mu^I_{i,j}),\\
\log(\mu^C_{i,j}) &= \mu_{i,j},\\
\log(\mu^I_{i,j}) &= \mu_{i,j} + \delta_{i,j},
\end{aligned}$$

$$
\begin{aligned}
\mu_{i,j} &\sim \text{Normal}(0, 10^5), \\
\delta_{i,j} &\sim \text{Normal}(\theta_i, \sigma_\delta^2), \\
\theta_i &\sim \text{Normal}(d, \sigma_\theta^2), \\
d &\sim \text{Normal}(0, 10^5), \\
\sigma_\delta &\sim \text{Uniform}(0, 10), \\
\sigma_\theta &\sim \text{Uniform}(0, 10),
\end{aligned}
$$

where r^C and r^I are the rates in the control and intervention areas. The true effect, d, is on the scale of a log rate ratio.

It is important to note that there is no weighting by study size for the rates meta-analysis. So a rate of 10% based on 10 observations is given equal weighting as a rate of 10% based on 1000 observations. This is because of a general lack of denominator information for studies reporting rates.

For the dengue death counts the Bayesian estimates from the binomial model were often 'trapped' because of the small number of deaths divided by some very large denominators. To avoid this numerical accuracy issue we instead fitted the counts of deaths using the Poisson model and included the denominators as offsets:

$$
\begin{aligned}
\log(\mu_{i,j}^C) &= \mu_{i,j} + \log(n_{i,j}^C/10,000), \\
\log(\mu_{i,j}^I) &= \mu_{i,j} + \log(n_{i,j}^I/10,000) + \delta_{i,j}.
\end{aligned}
$$

A great advantage of Bayesian meta-analysis is that it easily copes with zero cells, for example, no positive results from a control village. This happened often in our data because of the small sample sizes in some studies. In Frequentist meta-analysis these zero cells need to have an arbitrary constant added to them, otherwise the likelihood is non-estimable. Another advantage of a Bayesian meta-analysis is that the uncertainty in estimates can be expressed using a 95% credible interval, which has a 95% probability of containing the true estimate. This is in contrast to 95% confidence intervals, whose correct interpretation relies on imagining repeating the study multiple times, calculating multiple confidence intervals, and then counting the number of times the true estimate is contained in the intervals.

We used a leave-one-study-out sensitivity analysis in order to show if any study had a strong influence on the summary estimate. We only used this sensitivity analysis when there were more than two studies.

We plot the means and 95% credible intervals for the odds or rate ratios using the 'forestplot' function in the 'rmeta' library of R [2]. We made plots at both the study and result level to visually show both the between-study and between-result variability. Odds ratios or rate ratios under 1 mean the intervention is better; odds or rate ratios over 1 mean the intervention is worse.

The model was fitted using the WinBUGS software version 1.4.3 [3]. We used a burn-in of 10,000 iterations, and a sample of 10,000 iterations thinned by three.

Results for household index

Summary mean odds ratio = 0.21, and 95% credible interval =[0.05, 0.68].

Between-study standard deviation (σ_θ) mean = 1.64, and 95% credible interval =[0.82, 3.23].

Between-result standard deviation (σ_δ) mean = 0.71, and 95% credible interval =[0.47, 1.07].

First author (year)	Sample size control	Positive control	Sample size intervention	Positive intervention	Odds ratio
Crabtree (2001)	21	0	111	21	Inf
Crabtree (2001)	21	0	115	21	Inf
Crabtree (2001)	21	0	60	8	Inf
Crabtree (2001)	21	0	65	14	Inf
Crabtree (2001)	21	12	111	41	0.44
Crabtree (2001)	21	11	115	52	0.75
Crabtree (2001)	21	12	60	30	0.75
Crabtree (2001)	21	11	65	26	0.61
Eamchan (1989)	52	35	49	10	0.12
Igarashi (1997)	30	9	30	0	0
Madarieta (1999)	63	22	66	31	1.65
Madarieta (1999)	67	25	61	19	0.76
Madarieta (1999)	64	12	64	23	2.43
Madarieta (1999)	65	14	63	14	1.04
Madarieta (1999)	67	19	63	31	2.45
Pengvanich (2011)	60	32	60	2	0.03
Phan Urai (1995)	92	80	61	20	0.07
Phan Urai (1995)	92	77	61	16	0.07
Phan Urai (1995)	92	63	61	8	0.07
Phan Urai (1995)	92	62	61	16	0.17
Suroso (1990)	599	135	599	44	0.27
Suwanbamrung (2011)	230	117	230	104	0.8
Suwanbamrung (2011)	145	80	145	64	0.64
Suwanbamrung (2011)	139	88	139	43	0.26
Swaddiwudhipong (1992)	507	401	507	249	0.26
Swaddiwudhipong (1992)	507	401	507	357	0.63
Swaddiwudhipong (1992)	507	401	507	221	0.2
Swaddiwudhipong (1992)	507	401	507	294	0.36
Swaddiwudhipong (1992)	507	401	507	366	0.69
Swaddiwudhipong (1992)	507	401	507	300	0.38
Swaddiwudhipong (1992)	507	401	507	143	0.1
Swaddiwudhipong (1992)	507	401	507	216	0.2
Swaddiwudhipong (1992)	507	401	507	174	0.14
Therawiwat (2005)	155	95	132	26	0.15
Therawiwat (2005)	155	93	132	9	0.05

Table 1: Raw numbers for household index (35 results, 10 studies)

Study left out	Mean	Lower	Upper
Crabtree (2001)	0.18	0.05	0.51
Eamchan (1989)	0.23	0.06	0.80
Igarashi (1997)	0.27	0.09	0.89
Madarieta (1999)	0.17	0.05	0.48
Pengvanich (2011)	0.27	0.07	0.87
Phan Urai (1995)	0.24	0.06	0.93
Suroso (1990)	0.21	0.05	0.74
Suwanbamrung (2011)	0.19	0.05	0.72
Swaddiwudhipong (1992)	0.21	0.05	0.78
Therawiwat (2005)	0.23	0.04	0.79

Table 2: Leave-one-out sensitivity analysis for 10 household index studies. Mean odds ratios and 95% credible intervals.

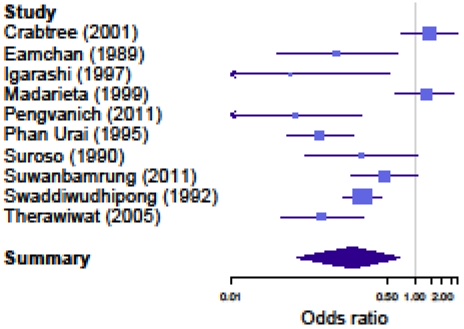

Figure 1: Forest plot of odds ratios for 10 household index studies.

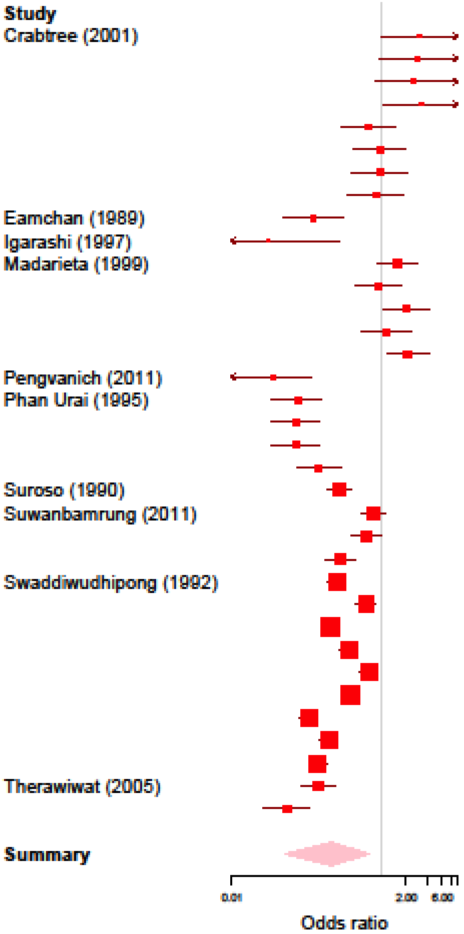

Figure 2: Forest plot of odds ratios for 33 household index results.

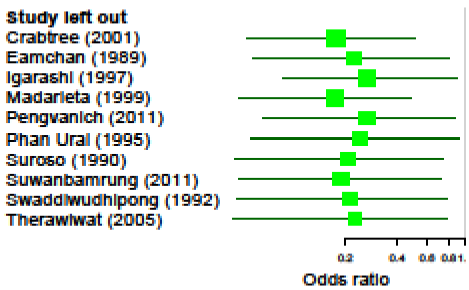

Figure 3: Leave-one-out sensitivity analysis for 10 household index studies. Mean odds ratios and 95% credible intervals.

Results for container index

First author (year)	Sample size control	Positive control	Sample size intervention	Positive intervention	Odds ratio
Madarieta (1999)	411	45	452	52	1.06
Madarieta (1999)	436	45	428	33	0.73
Madarieta (1999)	321	16	325	36	2.37
Madarieta (1999)	215	22	270	25	0.9
Madarieta (1999)	346	26	314	31	1.35
Phan Urai (1995)	741	296	550	66	0.21
Phan Urai (1995)	741	237	550	50	0.21
Phan Urai (1995)	741	207	550	17	0.08
Phan Urai (1995)	741	185	550	39	0.23
Suroso (1990)	1544	267	1442	148	0.55
Suwanbamrung (2011)	2597	623	1173	258	0.89
Suwanbamrung (2011)	2800	868	1720	206	0.3
Suwanbamrung (2011)	2014	504	1822	91	0.16
Swaddiwudhipong (1992)	3100	1212	3100	694	0.45
Swaddiwudhipong (1992)	3100	1212	3100	1066	0.82
Swaddiwudhipong (1992)	3100	1212	3100	521	0.31
Swaddiwudhipong (1992)	3100	1212	3100	865	0.6
Swaddiwudhipong (1992)	3100	1212	3100	946	0.68
Swaddiwudhipong (1992)	3100	1212	3100	766	0.51
Swaddiwudhipong (1992)	3100	1212	3100	366	0.21
Swaddiwudhipong (1992)	3100	1212	3100	666	0.43
Swaddiwudhipong (1992)	3100	1212	3050	305	0.17
Therawiwat (2005)	1952	402	2243	133	0.24
Therawiwat (2005)	2152	421	2234	71	0.13

Table 3: Raw numbers for container index (24 results, 6 studies)

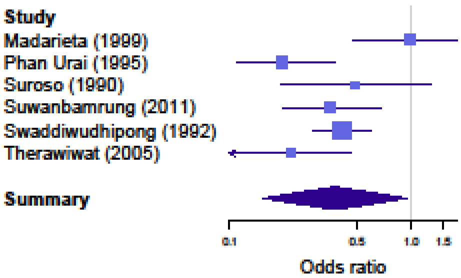

Figure 4: Forest plot of odds ratios for 6 container index studies.

Summary mean odds ratio = 0.38, and 95% credible interval =[0.15, 0.94].

Between-study standard deviation (σ_θ) mean = 0.92, and 95% credible interval =[0.22, 2.34].

Between-result standard deviation (σ_δ) mean = 0.58, and 95% credible interval =[0.4, 0.86].

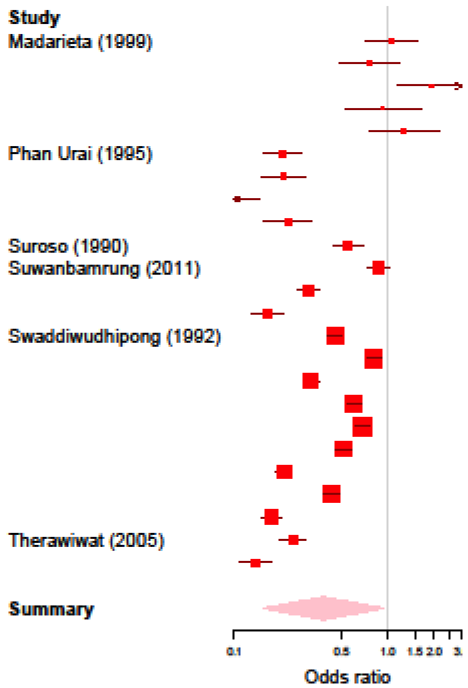

Figure 5: Forest plot of odds ratios for 22 container index results.

Study left out	Mean	Lower	Upper
Madarieta (1999)	0.30	0.15	0.69
Phan Urai (1995)	0.45	0.16	1.30
Suroso (1990)	0.36	0.11	1.26
Suwanbamrung (2011)	0.38	0.09	1.38
Swaddiwudhipong (1992)	0.37	0.09	1.46
Therawiwat (2005)	0.44	0.14	1.41

Table 4: Leave-one-out sensitivity analysis for 6 container index studies. Mean odds ratios and 95% credible intervals.

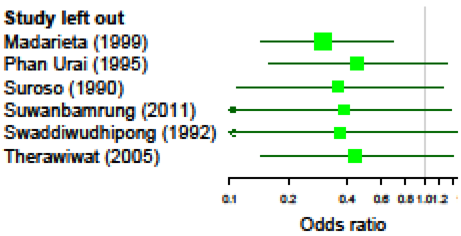

Figure 6: Leave-one-out sensitivity analysis for 6 container index studies. Mean odds ratios and 95% credible intervals.

Results for Breteau index

First author (year)	Rate control	Rate intervention	Rate ratio
Butraporn (1999)	100	53.5	0.54
Butraporn (1999)	105.1	51.5	0.49
Butraporn (1999)	112.1	40.8	0.36
Eamchan (1989)	221	33	0.15
Kay (2002)	48	32	0.67
Kay (2002)	76	48	0.63
Kay (2002)	36	7	0.19
Kay (2002)	68	31	0.46
Kay (2002)	46	11	0.24
Kay (2002)	21	3	0.14
Kay (2002)	35	3	0.09
Kay (2002)	39	25.7	0.66
Kay (2002)	34	11.3	0.33
Kay (2002)	25	5.7	0.23
Kay (2002)	42	4.3	0.1
Kay (2002)	62	5	0.08
Kay (2002)	60	3	0.05
Kay (2002)	30	1	0.03
Madarieta (1999)	71.4	78.8	1.1
Madarieta (1999)	67	54	0.81
Madarieta (1999)	25	56	2.24
Madarieta (1999)	33.8	33.3	0.99
Madarieta (1999)	38.8	46	1.19
Phan Urai (1995)	289	95	0.33
Phan Urai (1995)	241.2	78.2	0.32
Phan Urai (1995)	190.2	25.7	0.14
Phan Urai (1995)	167.1	52	0.31
Phatumachinda (1985)	425	133	0.31
Phatumachinda (1985)	489	140	0.29
Suroso (1990)	44	25	0.57
Suwanbamrung (2011)	303	130	0.43
Suwanbamrung (2011)	350	140	0.4
Suwanbamrung (2011)	358	65	0.18
Swaddiwudhipong (1992)	240.9	126.1	0.52
Swaddiwudhipong (1992)	240.9	216.7	0.9
Swaddiwudhipong (1992)	240.9	97.8	0.41
Swaddiwudhipong (1992)	240.9	220.5	0.92
Swaddiwudhipong (1992)	240.9	187.5	0.78
Swaddiwudhipong (1992)	240.9	153	0.64
Swaddiwudhipong (1992)	240.9	90.3	0.37
Swaddiwudhipong (1992)	240.9	131.4	0.55
Swaddiwudhipong (1992)	240.9	61.3	0.25
Therawiwat (2005)	259.3	100.7	0.39
Therawiwat (2005)	276.8	49.2	0.18
Tun-Lin (2009)	18.6	18.3	0.98
Tun-Lin (2009)	8	5.7	0.71
Umniyati (2000)	7	20.7	2.96
Umniyati (2000)	21.1	1	0.05
Umniyati (2000)	27.9	9.8	0.35

Table 5: Raw numbers for Breteau index (49 results, 12 studies)

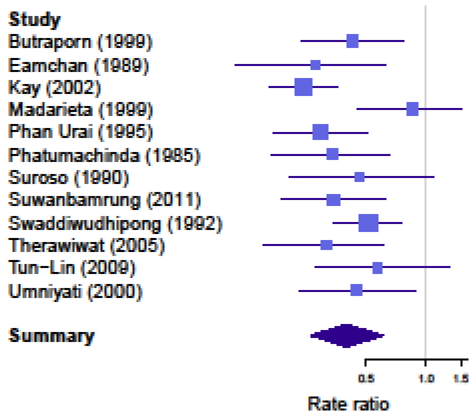

Figure 7: Forest plot of rate ratios for 12 Breteau index studies.

Summary mean rate ratio = 0.4, and 95% credible interval =[0.26, 0.61].

Between-study standard deviation (σ_θ) mean = 0.53, and 95% credible interval =[0.22, 1.02].

Between-result standard deviation (σ_δ) mean = 0.63, and 95% credible interval =[0.45, 0.85].

Study left out	Mean	Lower	Upper
Butraporn (1999)	0.39	0.24	0.62
Eamchan (1989)	0.42	0.27	0.63
Kay (2002)	0.43	0.28	0.64
Madarieta (1999)	0.35	0.25	0.51
Phan Urai (1995)	0.42	0.26	0.65
Phatumachinda (1985)	0.41	0.26	0.63
Suroso (1990)	0.39	0.25	0.60
Suwanbamrung (2011)	0.41	0.26	0.63
Swaddiwudhipong (1992)	0.38	0.24	0.60
Therawiwat (2005)	0.41	0.26	0.63
Tun-Lin (2009)	0.38	0.25	0.58
Umniyati (2000)	0.39	0.25	0.62

Table 6: Leave-one-out sensitivity analysis for 12 Breteau index studies. Mean rate ratios and 95% credible intervals.

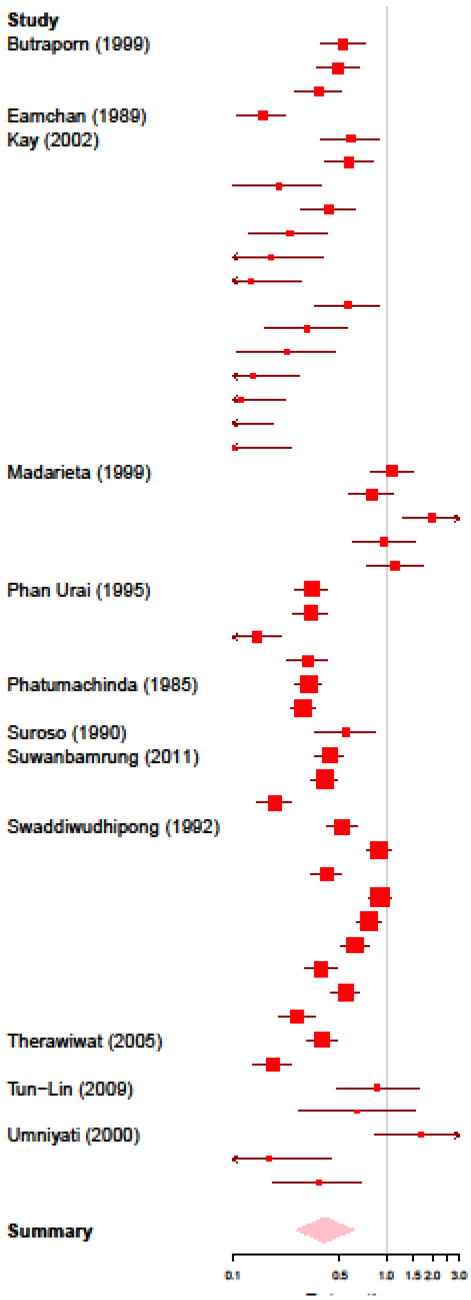

Figure 8: Forest plot of rate ratios for 46 Breteau index results.

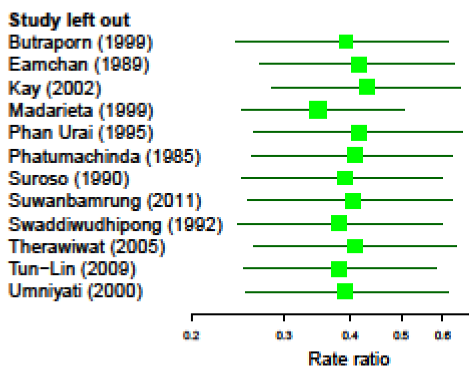

Figure 9: Leave-one-out sensitivity analysis for 12 Breteau index studies. Mean rate ratios and 95% credible intervals.

Results for density index

First author (year)	Rate control	Rate intervention	Rate ratio
Igarashi (1997)	0.53	0	0
Nam (1998)	0.05	0	0
Nam (1998)	0.2	0	0
Nam (1998)	0.15	0	0
Nam (1998)	0.25	0.15	0.6
Nam (1998)	0.3	0.1	0.33
Nam (1998)	0.95	0.25	0.26
Nam (1998)	0.3	0.2	0.67
Nam (1998)	0.2	0.1	0.5
Nam (1998)	0.55	0.25	0.45
Nam (1998)	0.75	0.2	0.27
Nam (1998)	0.25	0.15	0.6
Nam (1998)	0.05	0	0
Nam (1998)	0.2	0.05	0.25
Nam (1998)	0.2	0	0
Nam (1998)	0.45	0.1	0.22
Nam (1998)	0.5	0.05	0.1
Nam (1998)	1	0.05	0.05
Nam (1998)	1.7	0.1	0.06
Nam (1998)	0.7	0.05	0.07
Nam (1998)	0.6	0	0
Nam (1998)	0.75	0	0
Nam (1998)	0.45	0.05	0.11
Nam (1998)	0.3	0	0
Nam (1998)	0.3	0	0
Nam (1998)	0.15	0	0
Nam (1998)	0.15	0	0
Nam (1998)	0.15	0	0
Nam (1998)	0.25	0	0
Nam (1998)	0.25	0	0
Nam (1998)	0.65	0	0
Nam (1998)	0.45	0	0
Nam (1998)	0.7	0	0
Nam (1998)	0.2	0	0
Nam (1998)	0.2	0	0
Nam (1998)	0.1	0	0
Nam (1998)	0.25	0	0
Nam (1998)	0.1	0	0
Nam (2005)	0.7	0.3	0.43
Nam (2005)	0.33	0.18	0.55
Nam (2005)	0.1	0.22	2.2
Nam (2005)	0.23	0.19	0.83
Nam (2005)	0.23	0.13	0.57
Nam (2005)	0.12	0.04	0.33
Nam (2005)	0.22	0.05	0.23
Nam (2005)	0.61	0.05	0.08
Nam (2005)	0.84	0.03	0.04
Nam (2005)	0.35	0.01	0.03
Nam (2005)	0.4	0.01	0.02

Table 7: Raw numbers for density index (49 results, 3 studies)

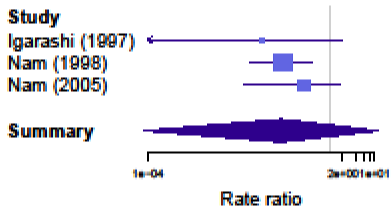

Figure 10: Forest plot of rate ratios for 3 density index studies.

Summary mean rate ratio = 0.09, and 95% credible interval =[0, 11.51].

Between-study standard deviation (σ_θ) mean = 3.13, and 95% credible interval =[0.13, 9.19].

Between-result standard deviation (σ_δ) mean = 0.59, and 95% credible interval =[0.01, 2.07].

Study left out	Mean	Lower	Upper
Igarashi (1997)	0.10	0.00	70.04
Nam (1998)	0.01	0.00	130.39
Nam (2005)	0.04	0.00	126.22

Table 8: Leave-one-out sensitivity analysis for 3 density index studies. Mean rate ratios and 95% credible intervals.

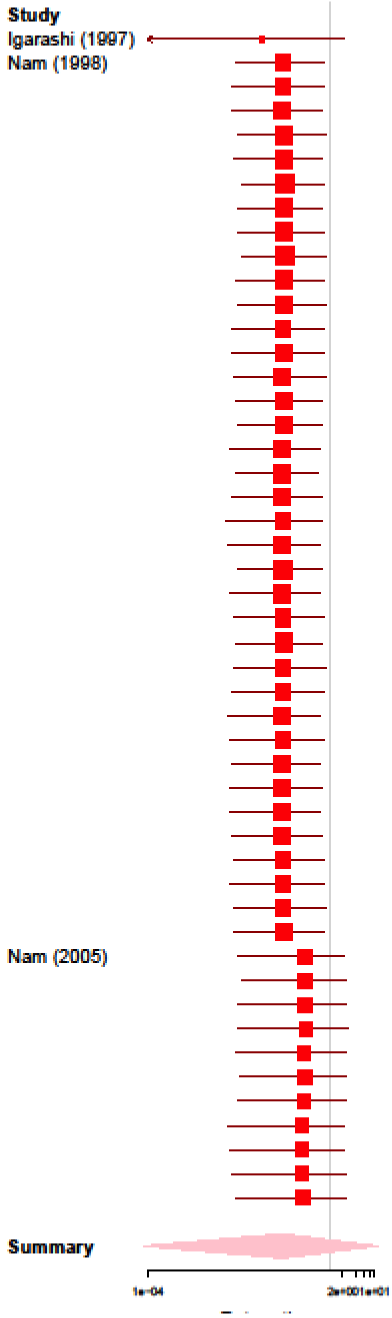

Figure 11: Forest plot of rate ratios for 38 density index results.

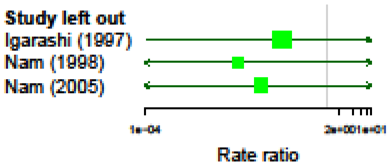

Figure 12: Leave-one-out sensitivity analysis for 3 density index studies. Mean rate ratios and 95% credible intervals.

Results for dengue cases

First author (year)	Rate control	Rate intervention	Rate ratio
Kay (2002)	2	8	3.8
Kay (2002)	23	0	0
Kay (2002)	0	0	NaN
Kittyapong (2008)	118	0	0
Nam (2005)	2230	15	0.95
Nam (2005)	1696	3	0.25
Nam (2005)	4329	0	0
Nam (2005)	553	0	0
Osaka (1999)	43	22	0.98
Osaka (1999)	43	16	0.31
Phatumachinda (1985)	8	33	4.12
Phatumachinda (1985)	25	6	0.24
Suaya (2007)	2585	1430	0.55
Suaya (2007)	2585	3795	1.47
Suaya (2007)	2585	3155	1.22
Suaya (2007)	2585	3195	1.24
Suaya (2007)	2585	1867	0.72
Swaddiwudhipong (1992)	181	185	0.34

Table 9: Raw numbers for dengue cases (18 results, 7 studies)

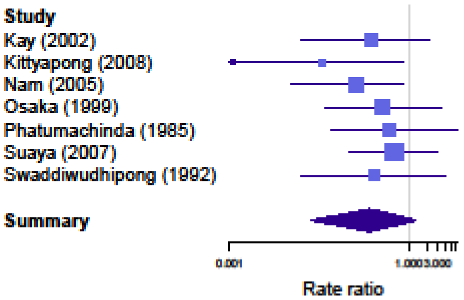

Figure 13: Forest plot of rate ratios for 7 dengue cases studies.

Summary mean rate ratio = 0.22, and 95% credible interval =[0.02, 1.32].

Between-study standard deviation (σ_θ) mean = 1.75, and 95% credible interval =[0.11, 5.68].

Between-result standard deviation (σ_δ) mean = 2.13, and 95% credible interval =[1.15, 3.69].

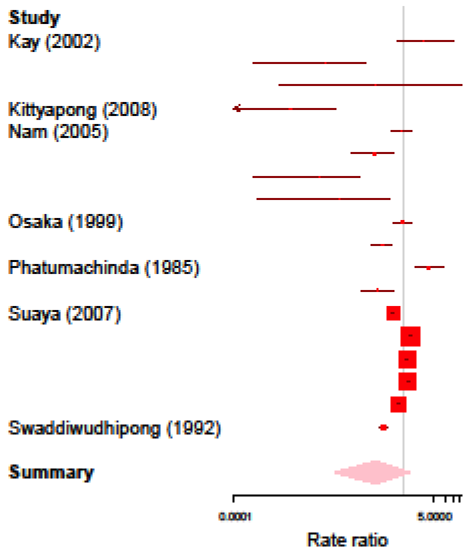

Figure 14: Forest plot of rate ratios for 17 dengue cases results.

Study left out	Mean	Lower	Upper
Kay (2002)	0.20	0.01	3.17
Kittyapong (2008)	0.45	0.11	1.60
Nam (2005)	0.26	0.01	2.44
Osaka (1999)	0.15	0.00	2.97
Phatumachinda (1985)	0.16	0.01	2.12
Suaya (2007)	0.09	0.00	2.30
Swaddiwudhipong (1992)	0.20	0.01	1.74

Table 10: Leave-one-out sensitivity analysis for 7 dengue cases studies. Mean rate ratios and 95% credible intervals.

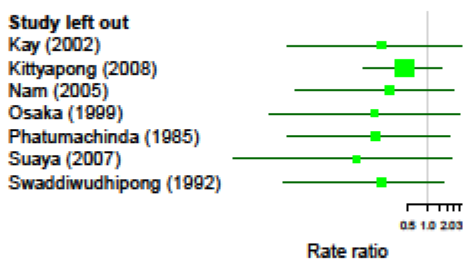

Figure 15: Leave-one-out sensitivity analysis for 7 dengue cases studies. Mean rate ratios and 95% credible intervals.

Results for mosquitoes per person per hour

First author (year)	Rate control	Rate intervention	Rate ratio
Butraporn (1999)	10.5	17.2	1.64
Butraporn (1999)	20.2	21.5	1.06
Butraporn (1999)	11.7	14.5	1.24
Phan Urai (1995)	5.3	4.2	0.79
Phan Urai (1995)	6.2	1.6	0.26
Phan Urai (1995)	4	1	0.25
Phan Urai (1995)	3.7	1	0.27

Table 11: Raw numbers for mosquitoes per person per hour (7 results, 2 studies)

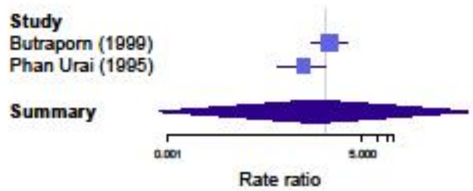

Figure 16: Forest plot of rate ratios for 2 mosquitoes per person per hour studies.

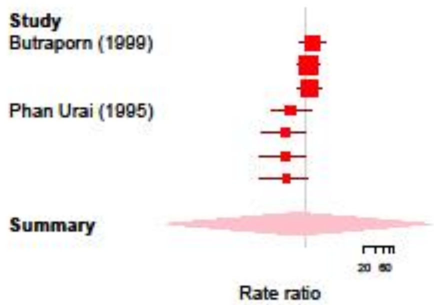

Figure 17: Forest plot of rate ratios for 7 mosquitoes per person per hour results.

Summary mean rate ratio = 0.68, and 95% credible interval =[0, 634.83].

Between-study standard deviation (σ_θ) mean = 3.51, and 95% credible interval =[0.22, 9.33].

Between-result standard deviation (σ_δ) mean = 0.4, and 95% credible interval =[0.01, 1.45].

Results for number larvae

First author (year)	Rate control	Rate intervention	Rate ratio
Kay (2002)	5778	3582	0.62
Kay (2002)	12878	3755	0.29
Kay (2002)	4204	1507	0.36
Kay (2002)	7601	1606	0.21
Kay (2002)	16720	544	0.03
Kay (2002)	5945	25	0
Kay (2002)	2005	74	0.04
Kay (2002)	43282	63203	1.46
Kay (2002)	12298	12642	1.03
Kay (2002)	6961	6824	0.98
Kay (2002)	11908	495	0.04
Kay (2002)	23061	629	0.03
Kay (2002)	16926	550	0.03
Kay (2002)	11707	54	0
Nam (2005)	2580	11448	4.44
Nam (2005)	540	3596	6.66
Nam (2005)	973	3074	3.16
Nam (2005)	1130	1632	1.44
Nam (2005)	2573	1850	0.72
Nam (2005)	424	763	1.8
Nam (2005)	1558	376	0.24
Nam (2005)	2284	443	0.19
Nam (2005)	4698	208	0.04
Nam (2005)	1955	100	0.05
Nam (2005)	960	11	0.01

Table 12: Raw numbers for number larvae (25 results, 2 studies)

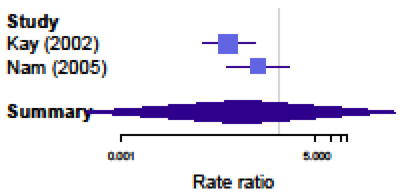

Figure 18: Forest plot of rate ratios for 2 number larvae studies.

Summary mean rate ratio = 0.21, and 95% credible interval =[0, 156.9].

Between-study standard deviation (σ_θ) mean = 3.48, and 95% credible interval =[0.16, 9.44].

Between-result standard deviation (σ_δ) mean = 2.15, and 95% credible interval =[1.59, 2.95].

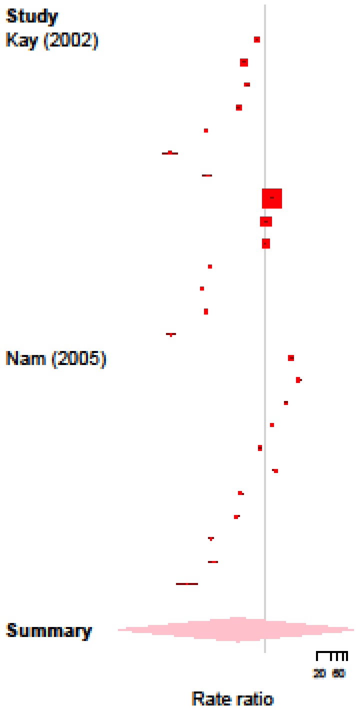

Figure 19: Forest plot of rate ratios for 25 number larvae results.

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