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Linking General Practice, Entomological Surveillance, Environmental Management, and Community Engagement An Integrative Review to Support Decision-Making in Public Health Vector Control Programmes

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ABSTRACT: Vector control programmes must connect observations about mosquitoes and their habitats with clinical information and feasible preventive actions. General practice provides a clinical interface through recognition, assessment, referral, and patient communication, while surveillance and environmental services address vector-related conditions. This theoretical integrative review examines how general practice, entomological surveillance, environmental management, and community engagement can inform coordinated public health decisions. Twenty purposively selected publications, supplemented by background literature and World Health Organization guidance, were examined within an eligible publication window from 2010 to November 2026. The core publications span 2012 through 2025 and include trials, observational analyses, physician surveys, and evidence syntheses, principally concerning Aedes mosquitoes and dengue. Narrative comparison distinguished clinical practice observations, entomological outcomes, human infection endpoints, implementation findings, and economic results. The synthesis identifies the need to connect clinical concerns with accountable reporting, interpret vector measures within their sampling context, assign feasible environmental responsibilities, and support community participation through practical services. Physician surveys inform training and diagnostic communication requirements but do not demonstrate reductions in infection or vector abundance. The resulting conceptual

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framework connects clinical and field observations with contextual assessment, intervention selection, implementation, and reassessment. Clinical decisions and vector control authorization retain separate professional responsibilities. The review establishes neither local effectiveness in Al-Ardah nor comparative superiority between interventions. Its contribution is an explicit description of coordination interfaces and evidence limitations. Future evaluation should examine feasibility, clinical reporting, implementation fidelity, costs, equity, and relevant health outcomes before attributing benefits to the proposed integrated framework in routine services.

1 INTRODUCTION

Public health vector control programmes depend on decisions about where, when, and how to act. General practitioners assess patients and communicate relevant clinical concerns, while field services examine vector-related conditions. Finding immature mosquitoes in a container can identify a habitat requiring attention, but it does not independently establish the probability of human infection or the best intervention for a wider area. Bowman et al. (2014) found limited and inconsistent relationships between conventional vector indices and dengue transmission. Cromwell et al. (2017) subsequently demonstrated that associations differed between cross-sectional and longitudinal mosquito measurements. These findings make the interpretation of surveillance information central to programme design. The question is how observations can inform defensible action while retaining their sampling limitations, geographic scale, and relationship to the outcome of interest.

The meaning of surveillance is especially important when routine indicators are used as automatic triggers. Morales-Pérez et al. (2020) found that conventional entomological indices had weak predictive utility for recent dengue infection in the settings examined. A statistically detectable association at cluster level did not provide a reliable household prediction rule. In contrast, Benitez-Valladares et al. (2021) examined responses to an early warning system combining epidemiological, meteorological, and entomological information. Their comparison suggested that the timing and coverage of response activities mattered, although the observational design limited causal conclusions. Together, these publications support treating surveillance as an input to contextual assessment rather than a self-sufficient prescription for intervention.

Environmental management connects this assessment with the material conditions that support vector breeding. Abeyewickreme et al. (2012) investigated waste management and community mobilization in Sri Lanka, linking household practices with local government services. Buhler et al. (2019) reviewed environmental interventions and found some effects on immature mosquito densities, alongside heterogeneous methods and outcomes. These studies indicate that habitat management involves both household action and service provision. A container may remain necessary for water storage, while removal of discarded receptacles may depend on reliable collection. Effective planning therefore requires identifying the habitat, understanding its use, and determining which actor can feasibly alter it without creating another health or livelihood problem.

Community engagement contributes to these decisions through local knowledge, participation, and feedback. Castro et al. (2012) evaluated an empowerment strategy embedded within routine dengue control and reported improvements in participation and infestation measures. Caprara et al. (2015) examined a participatory environmental intervention in Brazil and demonstrated reductions in vector density, while also documenting differences in local leadership and commitment. The interventions were packages of activities, so their effects cannot be assigned to one component alone. Their common relevance is that participation was supported through organization and practical action. This differs from assuming that greater awareness automatically produces sustained environmental change across households and public spaces.

Evidence concerning human infection strengthens the need to distinguish intermediate and epidemiological outcomes. Andersson et al. (2015) found that evidence-based community mobilization added benefits to conventional dengue control in a cluster randomized trial in Nicaragua and Mexico. The study measured serological infection as well as entomological indicators. However, Tschampl et al. (2020), analysing the same programme economically, showed that cost-effectiveness varied between the two countries under the research delivery arrangements. These are related publications with different questions, not independent replications. Their combination demonstrates why a programme decision should consider the measured health effect, the resources required, and the feasibility of integrating activities into existing services.

Broader assessments also caution against equating frequent use with established effectiveness. Araoz-Salinas et al. (2024) identified variation in physicians' knowledge associated with experience and guideline reading, supporting attention to clinical preparedness without proving effects on infection. Bowman et al. (2016) found substantial limitations in the evidence supporting dengue vector control, including limited randomized evidence for disease outcomes. Low et al. (2025) later identified continuing uncertainty in the systematic review literature. Such findings do not establish that all existing practices are ineffective. They indicate that the strength of a recommendation depends on intervention details, design quality, comparator, and endpoint. An integrative framework must make these distinctions visible rather than treating every published observation as equivalent support.

Insecticide resistance adds a further constraint to intervention selection. Moyes et al. (2017) documented geographically uneven evidence about resistance in major Aedes vectors and emphasized limitations in measurement and geographic coverage. Dusfour et al. (2019) examined resistance management principles and proposed approaches for preserving available tools. These publications support considering resistance information alongside operational capacity and vector characteristics. They do not justify inferring local susceptibility from a distant population or recommending a universal sequence of products. Decisions concerning chemical interventions require appropriately interpreted local evidence, authorized procedures, and attention to environmental and occupational responsibilities.

Targeted interventions illustrate why context remains important even when a study reports substantial effects. Vazquez-Prokopec et al. (2017) analysed location-based contact tracing and residual spraying during an Australian dengue outbreak, highlighting exposure beyond the home. Morrison et al. (2022) evaluated a spatial repellent in a cluster randomized trial in Peru and measured arboviral infection directly. These approaches address different mechanisms, delivery arrangements, and epidemiological settings. Their findings cannot be combined into a single ranking of operational options. For public health technicians, the relevant lesson is to document the rationale, reach, and conditions of an intervention so that subsequent observations can be interpreted against what was actually delivered.

Biological approaches further broaden the relationship between entomological observations and health outcomes. Pang et al. (2017) examined primary care physicians' diagnostic practices, follow-up, and prevention communication, illustrating the clinical interface through which patient information enters wider assessment. Utarini et al. (2021) demonstrated protection against virologically confirmed dengue through wMel deployments in a randomized trial in Indonesia. Pinto et al. (2021) reported associations between wMel deployments and reduced disease notifications in a Brazilian quasi-experimental evaluation. These results involve different strains, designs, and implementation conditions. They illustrate the importance of matching monitoring to mechanism: an intervention that changes mosquito transmission competence cannot be evaluated adequately through abundance measures alone.

This review therefore examines the interfaces connecting general practice, entomological surveillance, environmental management, and community engagement in public health vector control programmes. Its central question is how these functions can support context-sensitive decisions without overstating the available evidence. The review develops a conceptual framework linking observation, contextual interpretation, intervention selection, implementation, and reassessment. Clinical recognition, appropriate diagnostic assessment, referral, and patient advice are considered alongside responsibilities relevant to public health technicians, while retaining the need for entomological expertise, programme leadership, and authorized intersectoral cooperation. Although the contributors work in vector control, no local field data are analysed. The framework concerns selected international literature, principally about Aedes and dengue, and its applicability to Al-Ardah or other vector systems remains a question for subsequent evaluation.

2 LITERATURE REVIEW

2.1 Waste management and service coordination

Abeyewickreme et al. (2012) investigated community mobilization and household waste management in eight neighbourhoods in Sri Lanka. The intervention combined stakeholder partnerships, awareness activities, composting, and improved collection arrangements, with repeated entomological and social observations. The publication reported reductions in pupal measures associated with addressing productive discarded containers. Its small number of clusters and bundled intervention limit attribution to individual activities. Human infection reduction was not established by the entomological findings. For this review, the study connects habitat identification with practical responsibilities shared by households and

local authorities. It supports examining whether services can sustain the environmental changes requested from residents rather than evaluating awareness in isolation from waste collection and implementation conditions.

2.2 Community empowerment within routine services

Castro et al. (2012) conducted a cluster randomized trial in Havana using sixteen intervention and sixteen control clusters. Community empowerment was added to routine dengue control through organizational activities, risk surveillance, capacity building, and community work. Participation and knowledge improved, and the Breteau index remained lower in intervention clusters during the reported period. The measured outcomes concerned participation, practices, and infestation rather than confirmed human infection. Because empowerment was delivered as a package, component effects cannot be separated. The study contributes a service integration perspective: community action was embedded in an existing programme. Its relevance is the connection between local organization and routine delivery, while the durability and transferability of that relationship require contextual assessment.

2.3 Interpretation of entomological indices

Bowman et al. (2014) systematically reviewed eighteen studies examining quantitative relationships between vector indices and dengue cases. Designs and sampling methods varied, and most studies were classified as weak. Among thirteen studies examining associations, positive, absent, and inconclusive findings were all represented. Transmission was also reported below commonly used Breteau index thresholds. The review therefore did not establish a reliable universal index threshold for predicting outbreaks. Its contribution is to separate measuring infestation from estimating transmission risk. For the proposed framework, surveillance information requires interpretation alongside sampling design, timing, and epidemiological context. Limitations in the underlying studies also mean that uncertain predictive utility should not be interpreted as proof that all entomological observation lacks operational value.

2.4 General practice and clinical communication

Pang et al. (2017) compared questionnaire surveys of primary care physicians in Singapore before and after the major 2013 dengue epidemic. Reported diagnostic test use increased, follow-up practices changed, and physicians described more active education about warning signs and vector control. The surveys examined different response samples and relied on reported practice; changes cannot be attributed to a specific training intervention or interpreted as measured reductions in transmission. The study contributes a clinical coordination perspective: diagnostic access, follow-up, and patient communication affect how clinical information can support public health assessment. The framework therefore includes a general practice interface while retaining the distinction between clinical management, case notification, and authority to select vector control interventions.

2.5 Participatory environmental management

Caprara et al. (2015) compared ten intervention and ten control clusters in Fortaleza, Brazil. The participatory intervention included workshops, clean-up activities, container covering, engagement of schoolchildren and older residents, and educational materials. The study reported reduced vector density relative to routine control, with variation in community commitment and leadership. It evaluated an intervention package and cannot identify the independent effect of each social or environmental component. Nor should reduced infestation be equated with a measured reduction in dengue infection. Its contribution is the practical integration of participation with habitat management. The framework draws on this relationship while retaining the importance of local organization, coverage, and the service capacity required to maintain environmental changes.

2.6 Community mobilization and infection outcomes

Andersson et al. (2015) evaluated Camino Verde in 150 randomized clusters across Nicaragua and Mexico. Communities used baseline evidence to choose locally appropriate actions while routine government control continued in both groups. The intervention reduced serological evidence of dengue infection in children, reported illness, and entomological indicators. Relative reduction in the serological endpoint was 29.5%, with a 95% confidence interval from 3.8% to 55.3%. The open intervention and bundled delivery require attention to implementation context, although outcome assessment and analysis were blinded. The study directly links community mobilization with a human infection endpoint. Its results support

examining evidence-sharing and practical participation, without assuming the same effect size in another population or programme.

2.7 Effectiveness evidence across control methods

Bowman et al. (2016) reviewed forty-one studies of dengue vector control, with nineteen contributing to meta-analysis. Interventions, study durations, and designs varied substantially; comparatively few studies were randomized. The authors identified major gaps in reliable evidence for disease prevention and limited assessment of insecticide susceptibility in studies using chemical tools. Some approaches showed favourable associations, but methodological variation constrained interpretation. This publication provides a critical basis for distinguishing routine practice from demonstrated health benefit. For the framework, selection should retain information about comparator, intervention content, resistance assessment, and endpoint. The review also cautions against interpreting an evidence gap as a uniform finding of ineffectiveness across all control methods and contexts.

2.8 Longitudinal observation and infection risk

Cromwell et al. (2017) linked entomological information from Iquitos, Peru, with 8,153 paired serological samples from longitudinal cohorts. The analysis compared associations obtained from cross-sectional and repeated vector measurements. Higher cross-sectional densities were not associated with increased seroconversion risk, whereas several longitudinal measures were associated with infection. Observational associations do not establish that changing a particular index causes a corresponding change in disease. The study demonstrates that timing and measurement structure affect the apparent usefulness of surveillance. The proposed framework therefore records when, where, and how observations were collected. Repeated information can support interpretation, but the study does not supply a universally validated prediction rule or justify uncritical transfer of thresholds between settings.

2.9 Exposure locations and targeted action

Vazquez-Prokopec et al. (2017) analysed an Australian dengue epidemic using location-based contact tracing and spatial transmission modelling. The investigation identified potential exposure outside homes and examined targeted residual spraying at relevant premises. Sprayed premises had lower estimated subsequent transmission probabilities than unsprayed premises within the studied response. The analysis was observational and context-specific, so its estimates should not be treated as randomized intervention effects. Its contribution is to connect information about human movement with spatially targeted action. For this review, household infestation alone may inadequately represent exposure geography. The framework therefore includes contextual interpretation and authorized information exchange, while recognizing that contact-based targeting requires appropriate privacy arrangements, operational capacity, and local evaluation.

2.10 Resistance evidence and its geographic limits

Moyes et al. (2017) reviewed the distribution and mechanisms of insecticide resistance in major Aedes vectors. Evidence covered several insecticide classes and geographic regions but remained uneven in coverage and measurement. The review highlighted the need for standardized diagnostic approaches and cautioned against estimating resistance in unsampled locations. It did not test a single programme intervention or quantify the local performance of products in Al-Ardah. Its relevance is the relationship between evidence quality and chemical control decisions. Surveillance records should identify species, methods, sampling locations, and test interpretation where resistance information is used. The framework treats missing local evidence as uncertainty requiring assessment rather than as evidence of susceptibility or resistance.

2.11 Environmental intervention outcomes

Buhler et al. (2019) systematically reviewed nineteen studies of environmental dengue vector control, with sixteen contributing to meta-analysis. Interventions included container covering, waste management, clean-up activities, and elimination of breeding places. Effects on immature vector measures varied across methods and analytical approaches, with generally weak and heterogeneous evidence. The findings do not establish a universal ranking of environmental options or a corresponding reduction in human infection. This review contributes an outcome-sensitive interpretation of habitat management. The framework links the selected intervention to the locally relevant habitat and specifies what outcome is expected to change. It also preserves the distinction between environmental justification, entomological effects, and demonstrated epidemiological benefit when considering programme decisions.

2.12 Resistance management and programme planning

Dusfour et al. (2019) reviewed principles of insecticide resistance management for major Aedes vectors and proposed a planning framework informed by other vector systems and agricultural experience. The publication examined resistance evolution, monitoring approaches, and the preservation of effective insecticides. Its proposed management relationships are informed recommendations rather than a controlled demonstration of programme effectiveness. For this review, it connects entomological evidence with intervention stewardship and organizational planning. Decisions should consider the evidence supporting a product, monitoring capacity, and available alternatives within authorized arrangements. The study does not justify prescribing an insecticide sequence without local assessment. It supports incorporating resistance uncertainty into decision-making and evaluating the practical implementation of management strategies.

2.13 Physician preparedness and clinical interpretation

Araoz-Salinas et al. (2024) conducted an online cross-sectional survey of 359 Peruvian physicians concerning dengue diagnosis, management, and prevention. Higher knowledge was associated with guideline reading and clinical experience, while geographic variation was observed. The design cannot determine whether those exposures caused better knowledge, and questionnaire responses do not establish actual clinical performance or reduced disease incidence. The study supports examining access to current guidance and locally relevant learning opportunities. For this review, its contribution is the clinical interpretation needed between patient presentation and public health communication. It does not justify inferring the competence of an individual contributor or transferring physicians' responsibilities for diagnosis and referral to public health technicians.

2.14 Costs and programme integration

Tschampl et al. (2020) evaluated the costs and cost-effectiveness of Camino Verde using trial findings, micro-costing, and sensitivity analysis. The programme was marginally cost-effective in Mexico and not cost-effective in Nicaragua from the reported healthcare perspective under research delivery arrangements. These findings depended on costs, economic thresholds, management arrangements, and assumptions used in the analysis. This publication shares the underlying intervention with Andersson and colleagues and is not an independent efficacy trial. Its contribution is to show why health effects alone do not settle an implementation decision. The framework therefore includes resource requirements and integration with existing services, while avoiding transfer of reported monetary values or cost-effectiveness conclusions directly to another country.

2.15 Association and predictive performance

Morales-Pérez et al. (2020) analysed Camino Verde data from 150 clusters to examine relationships between entomological indices and recent dengue infection. None of the indices predicted infection usefully at household level. The Breteau index showed an association at cluster level but only weak predictive performance. The analysis illustrates why association does not necessarily provide a useful operational classifier. It shares programme data with the trial and economic evaluation discussed elsewhere, requiring attention to overlap. For this review, the principal contribution is the distinction between describing infestation and predicting infection. The framework requires explicit justification for any trigger and retains the possibility that exposure extends beyond the inspected household or immediate sampling area.

2.16 Randomized evidence for a biological intervention

Utarini et al. (2021) conducted a cluster randomized trial of wMel-infected Aedes aegypti deployments in Yogyakarta, Indonesia. Twelve clusters received deployments and twelve continued without them, alongside routine mosquito control. A test-negative design assessed virologically confirmed dengue among eligible febrile clinic attendees. Protective efficacy against symptomatic confirmed dengue was 77.1%, with a 95% confidence interval from 65.3% to 84.9%. The finding provides direct epidemiological evidence for that intervention in the trial setting. It does not establish equal effects across strains, delivery systems, or populations. The framework uses this study to illustrate mechanism-specific evaluation and the need for implementation capacity, appropriate governance, and human health endpoints when considering emerging tools

2.17 Implementation across a complex urban setting

Pinto et al. (2021) evaluated phased wMel deployments in Niterói, Brazil, using a quasi-experimental controlled interrupted time series. Routine notifications were compared across release areas and a predefined comparison area. Deployments were

associated with a 69% reduction in dengue incidence, with a 95% confidence interval from 54% to 79%, despite heterogeneous Wolbachia prevalence. The non-randomized design and reliance on surveillance notifications leave potential residual confounding and ascertainment differences. The study extends evidence about operational delivery but does not replicate the design of the Indonesian randomized trial. For this review, it supports attention to spatial coverage, establishment, and implementation context. The framework treats such findings as complementary rather than directly interchangeable estimates.

2.18 Early warning and operational response

Benitez-Valladares et al. (2021) compared response activities in eleven purposively selected Mexican health districts using a dengue early warning system. Nine districts experienced alarms without subsequent outbreaks and two experienced alarms followed by outbreaks. Earlier and more extensive response activity was observed in districts without subsequent outbreaks. Because selection and response were not randomized, the comparison cannot establish that the response alone prevented outbreaks. The study contributes an operational explanation for why prediction and implementation must be assessed separately. The proposed framework therefore connects an interpreted signal with feasible action, coverage, and follow-up. It also requires documenting uncertainty and competing explanations rather than using the absence of an outbreak as automatic proof of intervention success.

2.19 A trial with an infection endpoint

Morrison et al. (2022) evaluated a transfluthrin-based spatial repellent in twenty-six randomized clusters in Iquitos, Peru. The trial included 2,907 households and assessed seroconversion among 1,578 participants for its primary endpoint. The intervention reduced Aedes-borne viral infection by 34.1%, with a one-sided 95% confidence lower limit of 6.9%. Entomological measures were also examined. The endpoint and interval differ from those used in other intervention studies, so estimates should not be ranked as directly comparable. For the framework, the trial demonstrates the value of specifying an infection outcome alongside vector measurements. Local adoption would still require consideration of authorization, delivery, exposure conditions, feasibility, and resources rather than reliance on one efficacy estimate.

2.20 Continuing uncertainty in review evidence

Low et al. (2025) conducted a meta-review of systematic reviews concerning dengue vector control. Fifteen reviews were included, while detailed narrative synthesis focused on three examining randomized evidence. Findings indicated continuing limitations in the evidence and difficulties created by differences and overlap among underlying trials. This publication is a synthesis of reviews, not a new intervention evaluation or a direct comparison of all contemporary tools. Its contribution is to caution against treating repeated citation as independent confirmation. The proposed framework therefore retains evidence provenance and separates primary evaluations from secondary summaries. Its conclusions support further rigorous evaluation while not invalidating specific trial findings that answer narrower questions under clearly defined conditions.

2.21 Synthesis and research gap

Clinical surveys add a general practice interface, while retaining their self-report and observational limitations. The selected literature supports integration as a question of how activities are connected and evaluated. Community trials demonstrate that environmental action can be organized through participation, but their bundled interventions limit attribution. Surveillance analyses show that an index can be informative about infestation without providing a reliable prediction of infection. Resistance reviews identify another decision constraint, while emerging tools require indicators matched to their biological mechanisms. These contributions have different evidential status. Related Camino Verde publications share programme data, and reviews may incorporate primary studies also discussed individually. Counting publications therefore cannot establish the number of independent confirmations. Within this corpus, a remaining gap concerns the evaluation of the complete decision pathway linking clinical and field observation, interpretation, responsibility, implementation, and reassessment. The present review addresses that conceptual gap without claiming that no related framework exists elsewhere or that the proposed arrangement has demonstrated effectiveness.

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3 METHODOLOGY

3.1 Research design and question

This study uses a theoretical integrative review to examine how general practice, surveillance, environmental management, and community engagement can inform public health vector control decisions. The unit of analysis is a decision interface: a point at which information must be interpreted, responsibility assigned, or action evaluated. The question is how these interfaces can be organized while respecting evidence limitations and local implementation conditions. The design allows comparison across trials, observational studies, reviews, and critical assessments. It follows the methodological distinction between describing existing publications and developing a reasoned conceptual synthesis (Snyder, 2019; Torraco, 2016). It is not an exhaustive systematic review, meta-analysis, or evaluation of the contributors' workplace.

3.2 Source identification and eligibility

Targeted web searches located publications through indexed records, original journals, PubMed, PubMed Central, and World Health Organization resources. Search concepts included entomological indices, dengue transmission, community mobilization, environmental management, insecticide resistance, targeted vector control, Wolbachia, and early warning systems, primary care, clinical recognition, diagnostic practice, and physician preparedness. Exact titles and identifiers were used to verify publication identity. Europe PMC records supplied bibliographic metadata and abstracts; accessible full-text articles supplemented this information. Searches were completed on November 17, 2026. Eligibility extended from January 2010 to that date, while the selected substantive corpus spans 2012–2025. The search was purposive and iterative, without a database-wide retrieval denominator or a registered protocol. No claim of comprehensive coverage or duplicate independent screening is made.

3.3 Selection boundaries and source access

Twenty substantive publications were selected for their contributions to surveillance interpretation, clinical practice, environmental action, participation, intervention choice, or evaluation. The revised corpus incorporates two physician surveys and retains a meta-review, with evidence types clearly distinguished. Eighteen core publications were accessible as full text, while two were assessed through indexed abstracts. Table 1 states selection boundaries, and Table 2 identifies design and access. Background assessments, four WHO publications, and two methodological sources supply additional context and are excluded from the twenty-study count. Clinical guidance supports interpretation of the general practice role; it does not convert physician knowledge surveys into evidence of improved population outcomes.

Table 1. Selection criteria and interpretive boundaries

Dimension	Eligible material	Boundary
Period	Publications from 2010 to November 17, 2026	Selected substantive sources span 2012–2025.
Relevance	Clinical practice, surveillance, environmental action, participation, or evaluation	A decision interface must be identifiable.
Design	Trials, observational analyses, reviews, and critical assessments	Evidence types remain distinguishable.
Verification	Indexed identifier and original publication record	Unverifiable citations are excluded.
Access	Full text or an informative indexed abstract	Claims do not exceed accessible content.
Geography	International research relevant to programme functions	No local applicability is presumed.
Overlap	Related analyses with distinct contributions	Shared data do not represent independent replication.

Table 2. Substantive evidence corpus and source access

Publication	Design	Main contribution	Access
Abeyewickreme et al. (2012)	Intervention study	Waste and service coordination	Full text
Castro et al. (2012)	Cluster randomized trial	Empowerment within routine services	Indexed abstract
Bowman et al. (2014)	Systematic review	Indices and transmission	Full text
Pang et al. (2017)	Repeated cross-sectional surveys	Clinical practice and communication	Full text
Caprara et al. (2015)	Cluster randomized trial	Participatory habitat management	Full text
Andersson et al. (2015)	Cluster randomized trial	Mobilization and infection	Full text
Bowman et al. (2016)	Systematic review and meta-analysis	Control effectiveness evidence	Full text
Cromwell et al. (2017)	Longitudinal observational analysis	Sampling and infection association	Full text
Vazquez-Prokopec et al. (2017)	Observational spatial analysis	Exposure and targeted response	Full text
Moyes et al. (2017)	Evidence review	Resistance distribution	Full text
Buhler et al. (2019)	Systematic review and meta-analysis	Environmental control outcomes	Full text
Dusfour et al. (2019)	Review and proposed framework	Resistance management	Full text
Araoz-Salinas et al. (2024)	Cross-sectional physician survey	Knowledge and preparedness	Full text
Tschampl et al. (2020)	Trial-based economic evaluation	Costs and integration	Indexed abstract
Morales-Pérez et al. (2020)	Secondary predictive analysis	Indices and prediction	Full text
Utarini et al. (2021)	Cluster randomized trial	Wolbachia and confirmed dengue	Full text
Pinto et al. (2021)	Quasi-experimental time series	Urban deployment outcomes	Full text
Benitez-Valladares et al. (2021)	Observational programme evaluation	Early warning and response	Full text
Morrison et al. (2022)	Cluster randomized trial	Repellent and infection	Full text

Publication	Design	Main contribution	Access
Low et al. (2025)	Meta-review	Review overlap and uncertainty	Full text

3.4 Evidence organization and appraisal

For each publication, the synthesis records the purpose, setting, design, intervention or exposure, endpoint, relevant finding, and limitations. Bibliographic details are checked against indexed identifiers. Narrative appraisal considers whether the design supports causal inference, whether outcomes concern mosquitoes or human health, whether comparators are appropriate, and whether findings depend on assumptions or specific delivery conditions. Physician surveys are assessed for sampling and self-report limitations. No numerical quality score, formal certainty grade, or standardized risk-of-bias assessment is reported. Information unavailable in an abstract is not reconstructed. Formal dual extraction, agreement statistics, and consensus meetings have not been documented and are not claimed.

3.5 Programme overlap and transferability

Publications are also examined for shared underlying data and conceptual overlap. The Camino Verde trial, economic evaluation, and predictive-index analysis contribute different findings but cannot be counted as three independent intervention trials. Systematic reviews and the meta-review may incorporate studies also represented in the corpus. The analysis therefore compares the contribution of each source instead of pooling publication counts as evidence strength. Transferability is considered in relation to vector species, epidemiological setting, sampling scale, water and waste services, and implementation capacity. Evidence concentrated on Aedes and dengue does not automatically apply to Anopheles, sandflies, or every vector-borne disease.

3.6 Narrative integration and framework construction

The analysis organizes findings into clinical communication, surveillance interpretation, environmental feasibility, supported participation, intervention selection, and reassessment. Within each domain, source findings are distinguished from integrative interpretations and untested framework propositions. The proposed pathway connects an observation with contextual assessment, an authorized choice, implementation, and review of the relevant outcome. Table 3 specifies the information and responsibilities considered at these interfaces. WHO guidance informs the operational context for integrated management and resistance assessment (World Health Organization [WHO], 2012, 2017, 2022, 2025). Clinical recognition and appropriate referral remain within qualified clinical practice. The framework is a conceptual output rather than a validated decision rule or a substitute for local technical authority.

Table 3. Proposed interfaces for programme decision-making

Interface	Information considered	Responsibility to define	Evaluation focus
Observation	Species, habitat, sampling method, time, location	Field collection and technical verification	Completeness and comparability
Clinical assessment	Presentation, appropriate testing, referral, reporting	General practitioner and authorized reporting recipients	Clinical information and confidentiality
Interpretation	Repeated observations, epidemiology, service conditions	Technical assessment and programme review	Rationale and uncertainty
Selection	Evidence, resistance, feasibility, authorization	Decision authority and delivery partners	Mechanism and intended endpoint
Implementation	Coverage, access, supplies, community feedback	Operational delivery and service support	What was delivered and where

Interface	Information considered	Responsibility to define	Evaluation focus
Reassessment	Repeat sampling, relevant health outcomes, costs	Review ownership and corrective action	Implementation and outcome distinction

3.7 Quantitative information and figure construction

No new effect estimate or pooled comparison is calculated. Numerical findings remain attached to their source, population, endpoint, and uncertainty. Results figures comprise an endpoint distinction diagram, a chart of three randomized trial estimates displayed in separate panels, and a conceptual decision pathway. The trial panels retain different endpoints and confidence interval conventions; their visual proximity does not establish comparative effectiveness. Conceptual arrows represent proposed relationships, not measured causal effects. No local performance scores, invented sample sizes, or simulated reduction percentages are introduced. The results are therefore a literature synthesis supported by transparent illustrations.

3.8 Ethical considerations

The study uses publicly accessible literature and institutional guidance, with no recruitment, identifiable patient information, field sampling, or confidential operational records. No ethics approval, exemption, consent waiver, or institutional endorsement is claimed. Any required institutional determination remains a matter for the relevant organization. Ethical reporting requires accurate attribution, preservation of uncertainty, and separation of observed evidence from proposals. Community participation is interpreted with attention to practical constraints and the risk of shifting service responsibilities onto households. Clinical information exchange requires appropriate confidentiality and role-based access. General practice responsibilities remain distinct from field control authority. Chemical or biological control options are discussed academically, without authorizing deployment. The contributors' roles, authorship order, correspondence details, funding, and competing interests require confirmation before submission. Personal contact information is supplied for manuscript administration and is not research data. Future local evaluation would require its own protocol, applicable permissions, and appropriate ethical and data-protection arrangements.

3.9 Methodological limitations

Purposive selection and incomplete full-text access can omit relevant findings. The corpus is geographically and biologically uneven, and newer publications may not be captured comprehensively. Narrative appraisal cannot replace a formal systematic assessment of bias. No external expert panel or local validation exercise was conducted. These limitations restrict claims to an interpretation of the selected evidence and the generation of testable organizational propositions. They do not permit conclusions about current vector density, insecticide susceptibility, community behaviour, or programme effectiveness in Al-Ardah.

4 RESULTS

4.1 Evidence profile and central interpretation

The review identifies six connected decision requirements: linking clinical concerns with public health assessment, interpreting surveillance in context, selecting environmentally feasible actions, supporting participation through services, matching interventions to evidence and local conditions, and reassessing implementation against relevant outcomes. These are integrative interpretations of the selected publications. They are not measured changes in a local programme. The twenty-publication corpus contains five cluster randomized trials, nine other primary or secondary empirical analyses, and six evidence syntheses. Design categories describe publications rather than independent intervention datasets. The same Camino Verde programme contributes a trial, an economic evaluation, and a predictive analysis, while reviews can incorporate primary studies discussed separately. The principal conceptual result is that integration requires explicit interfaces between functions, not simply the simultaneous presence of several activities.

4.2 Surveillance describes different objects

Clinical suspicion and confirmed infection also remain distinct. The evidence distinguishes a habitat observation, an estimate of vector abundance, a measure of transmission competence, and a human infection outcome. These objects are related but

not interchangeable. Bowman et al. (2014) found inconsistent associations between conventional indices and dengue cases. Cromwell et al. (2017) showed that repeated measurements and one-time observations could yield different relationships with infection. Morales-Pérez et al. (2020) further demonstrated that a cluster-level association did not necessarily provide useful prediction. Figure 1 therefore separates endpoint domains instead of arranging them as an automatic causal ladder. A reduction in positive containers can be a relevant entomological result while remaining insufficient evidence of reduced disease. Equally, an intervention affecting transmission competence may produce health benefits without requiring a proportional decline in mosquito abundance. This distinction changes how monitoring questions should be framed.

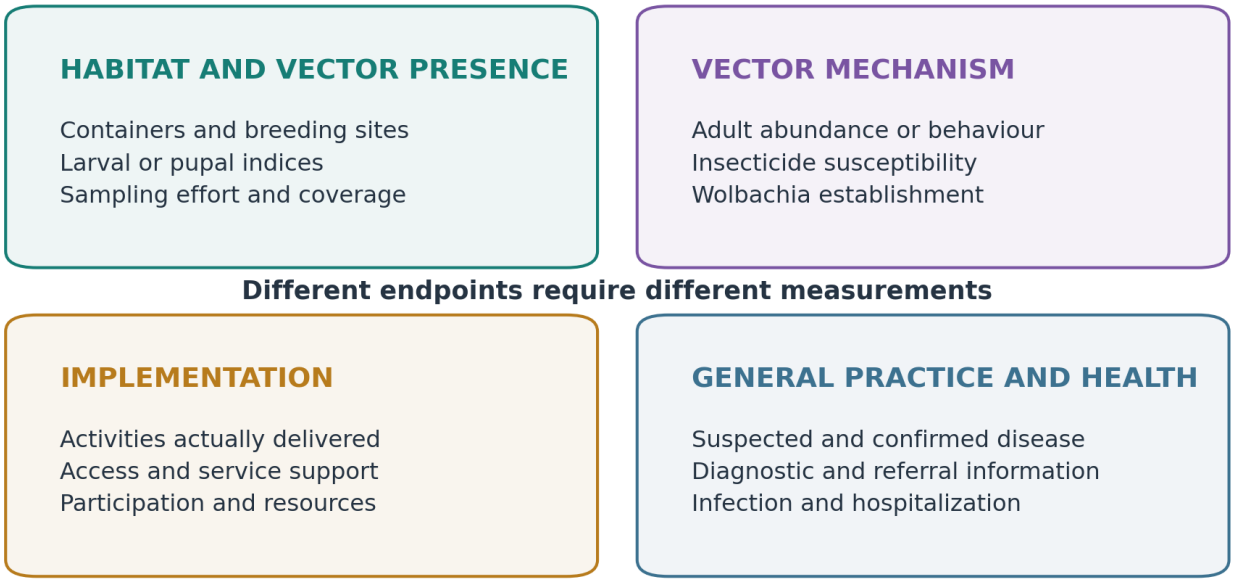

Figure 1. Distinct endpoint domains used in the synthesis. Original conceptual illustration; the four domains are not a causal ladder or equivalent measures of programme success.

4.3 Environmental action requires a feasible service arrangement

Habitat management findings connect environmental priorities with the capacity to act on them. Abeyewickreme et al. (2012) linked household waste activities to local collection arrangements. Caprara et al. (2015) and Castro et al. (2012) combined environmental action with community organization and routine services. Buhler et al. (2019) found heterogeneous entomological effects across environmental approaches. The synthesis therefore supports assessing both the productive habitat and the practical reason it persists. Where water storage remains necessary, a feasible protective arrangement differs from simply requesting container removal. Where discarded receptacles accumulate because collection is unreliable, educational messages do not resolve the service gap. The resulting framework proposition is to document the actor, enabling service, and expected maintenance requirement for each selected environmental action. That proposition has not been tested as a complete intervention in this review.

4.4 Participation involves decision-making and material support

Andersson et al. (2015) provide randomized evidence that locally adapted mobilization can add benefit to conventional control under the trial conditions. Their 29.5% relative reduction in serological infection in children is an original trial estimate, not an effect of the framework developed here. Participation in the reviewed programmes included discussion of local evidence and practical work, rather than information provision alone. The analysis consequently identifies a distinction between receiving advice and having an opportunity to influence and implement a feasible response. Tschampl et al. (2020) also show that resource arrangements affect the economic interpretation of participation. A strategy can demonstrate health benefit while requiring delivery changes to become affordable. This supports attention to service integration and opportunity costs without presuming that volunteer time is unlimited or costless. General practice can reinforce prevention advice and

identify questions requiring clinical review; this proposed interface does not establish that counselling independently reduces vector abundance.

4.5 Human infection effects cannot be ranked across trials

Figure 2 reproduces three randomized trial estimates in separate panels. The Camino Verde trial reported a 29.5% relative reduction in serological infection among children, with a two-sided 95% confidence interval of 3.8–55.3% (Andersson et al., 2015). The Indonesian Wolbachia trial reported 77.1% protective efficacy against symptomatic virologically confirmed dengue, with a two-sided 95% interval of 65.3–84.9% (Utarini et al., 2021). The Peruvian spatial repellent trial reported 34.1% protection against Aedes-borne viral infection, with a one-sided 95% lower confidence limit of 6.9% (Morrison et al., 2022). These values come from different populations, interventions, estimands, and endpoints. A taller or more rightward estimate cannot establish superiority. The figure illustrates availability of human infection evidence and the need to retain its statistical meaning. No pooled value, comparative test, or ranking is derived.

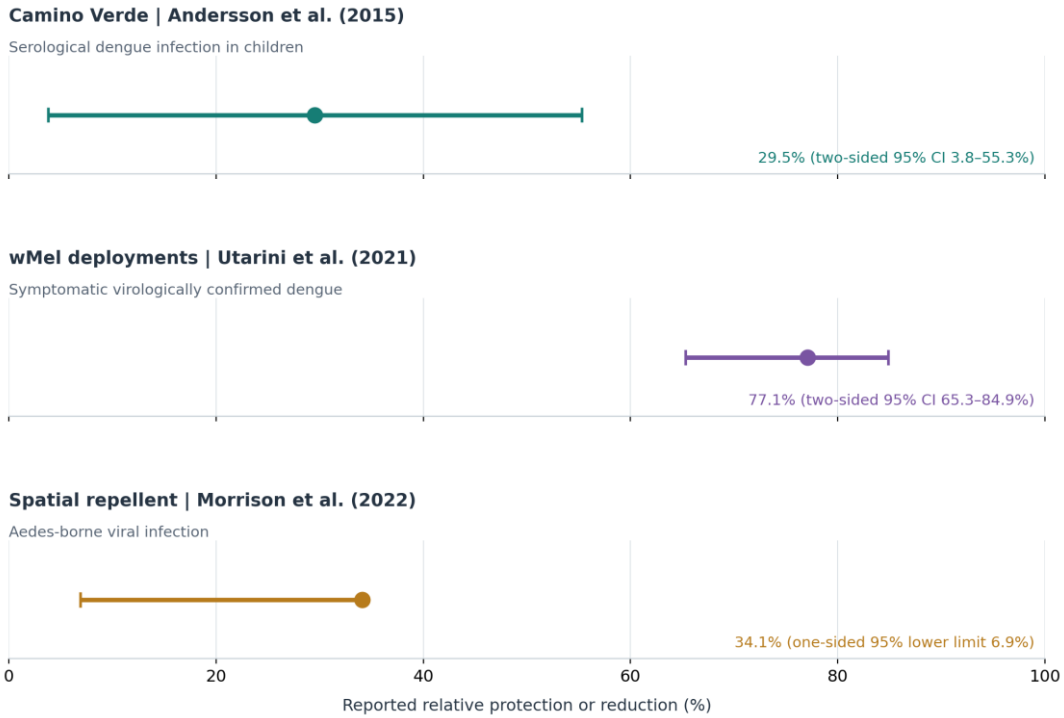

Figure 2. Published randomized trial estimates, shown separately because endpoints and estimands differ. Sources: Andersson et al. (2015), Utarini et al. (2021), and Morrison et al. (2022). The spatial repellent panel shows a one-sided lower confidence limit, not a two-sided interval. No pooled or comparative estimate is calculated.

4.6 Intervention choice requires mechanism and context

Resistance and biological intervention publications reinforce the need for context-sensitive selection. Moyes et al. (2017) and Dusfour et al. (2019) show why susceptibility cannot be inferred safely from unsampled locations or an intervention's historical use. Nazni et al. (2019) documented variation in biological establishment across sites. Pinto et al. (2021) reported disease-notification reductions in a complex urban deployment using a quasi-experimental design. The randomized result of Utarini et al. (2021) supplies stronger causal evidence for a specified intervention but does not remove questions of implementation, authorization, or transferability. The synthesis therefore separates evidence that a tool can work from evidence that a particular service can deliver and sustain it. Appropriate monitoring must match the mechanism: resistance assays, establishment measures, operational coverage, and infection outcomes answer different questions.

4.7 Spatial targeting and early warning need accountable action

Vazquez-Prokopec et al. (2017) identify the relevance of potential exposure outside the home, while Benitez-Valladares et al. (2021) connect warning signals with the timing and coverage of response activities. Both are observational and should retain

their contextual limitations. Their combined contribution is the recognition that information must reach a decision process capable of acting on the relevant geography and timescale. Figure 3 represents this relationship through a proposed programme pathway. It includes a check on uncertainty, feasibility, and authority before intervention selection. Reassessment can revise the habitat priority, delivery arrangement, or interpretation of the initial signal. Clinical concerns enter through qualified assessment and accountable reporting, not automatic classification from a vector index. The pathway is not a universal response algorithm; different vector systems and hazards require different technical standards and authorized actions.

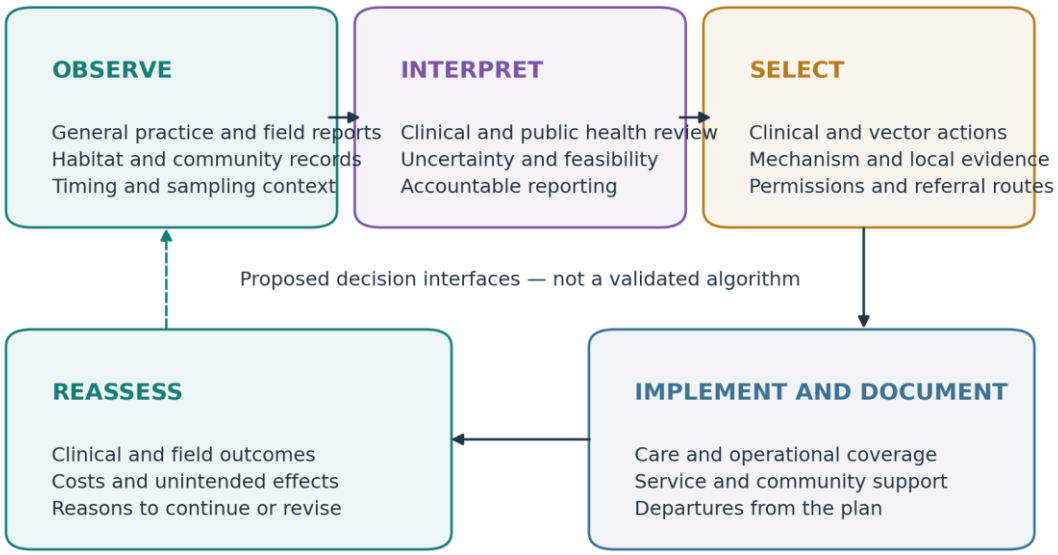

Figure 3. Proposed programme decision interfaces derived from the narrative synthesis. Arrows indicate conceptual information and action relationships. This pathway has not been validated locally or evaluated as a combined intervention.

4.8 General practice and public health technician interfaces

General practice adds a clinical interface involving assessment of suspected disease, appropriate diagnostic decisions, referral, follow-up, and patient communication within applicable guidance (WHO, 2025). Pang et al. (2017) and Araoz-Salinas et al. (2024) identify training and communication considerations, but their survey findings do not demonstrate improved care or reduced transmission. The proposed framework connects clinical reports with field observations through accountable public health assessment. Technicians contribute comparable habitat records, implementation information, and community concerns within assigned duties. Their responsibilities remain distinct from diagnosis and referral, while general practitioners do not acquire independent authority over insecticide selection or biological releases through this framework. Patient-level clinical decisions should not be inferred from mosquito indices. The revised contributor information identifies one general practitioner and seven public health technicians; it is not an assessment of local staffing or performance.

4.9 Evaluation and uncertainty

The final analytical requirement is to distinguish implementation from outcome. Activities completed, households reached, or containers addressed document delivery. Changes in vector observations document an entomological endpoint. Human infection, symptomatic disease, and hospital admission remain separate health outcomes. Costs and distribution of burdens add further evaluation questions. Achee et al. (2015), Bowman et al. (2016), and Low et al. (2025) demonstrate why evidence limitations must remain visible when programmes combine tools. The proposed framework therefore retains records of the original rationale, implementation conditions, and unresolved uncertainty. It does not supply universal numerical triggers or claim synergy between components. Its value is to specify decisions that can be examined empirically, including whether information was interpretable, an action feasible, coverage adequate, and the chosen outcome measured appropriately.

5 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This integrative review examined how general practice, entomological surveillance, environmental management, and community engagement can support decisions in public health vector control programmes. Clinical assessment connects suspected illness with care and reporting. These functions address connected but distinct questions. Surveillance describes vectors and habitats within particular sampling conditions; environmental management requires feasible changes to those conditions; and participation depends on organization, support, and opportunities for local input. Evidence about human infection cannot be inferred automatically from changes in mosquito indices. Intervention trials, observational analyses, reviews, and economic evaluations therefore require different interpretations. The synthesis developed a conceptual pathway connecting observation, contextual assessment, intervention selection, implementation, and reassessment. Its contribution is to clarify clinical and field responsibilities while retaining uncertainty about prediction, transferability, and implementation. Resistance evidence and biological approaches further show why monitoring must match intervention mechanisms rather than rely on one standard indicator. The review also identifies limits in the evidence base, including heterogeneous outcomes, overlapping publications, incomplete full-text access, and concentration on Aedes and dengue. These limits prevent claims of comprehensive coverage or universal applicability. No local effectiveness, validated decision threshold, or benefit attributable to the proposed framework was demonstrated. The framework instead provides an evidence-informed structure for programme discussion and future investigation. Application in Al-Ardah or another setting would require confirmation of vector ecology, service arrangements, professional responsibilities, and authorized technical procedures. Subsequent evaluation should examine feasibility, implementation fidelity, costs, equity, and health outcomes before treating the integrated pathway as an established standard for vector control practice.

5.2 Recommendations

Public health programmes should connect general practice reporting with field assessment and intervention decisions. Surveillance records should retain species identification, sampling methods, location, timing, so that trends can be interpreted appropriately. Clinical care and infection prediction should not rely solely on infestation indices. Environmental priorities should reflect productive habitats and the services needed to change them, including water storage arrangements and reliable waste collection. Community engagement should provide opportunities to discuss evidence, identify barriers, and shape feasible actions without transferring institutional responsibilities onto households. General practitioners should follow current clinical guidance for assessment, testing, referral, and follow-up. Training should support clinical reporting and field communication within professional boundaries. Chemical and biological interventions should be considered through applicable authorization, local evidence, mechanism, feasibility, and resources. Resistance data from distant populations should not substitute for appropriate assessment of local conditions. Evaluation should distinguish delivery measures, entomological outcomes, infection outcomes, costs, and unintended consequences. Programme reviews should record why an action was chosen, what was delivered, and whether subsequent information supports continuation or revision. Future research should test the proposed framework prospectively through feasibility studies and comparative evaluations. Such work should address sampling quality, implementation fidelity, community experience, service capacity, and distribution of burdens. Investigators should account for seasonality, concurrent interventions, population movement, and changes in case ascertainment when examining health outcomes. Before publication, contributors should verify affiliations, contact details, authorship contributions, funding, and competing interests. Local implementation should proceed through institutional procedures and qualified oversight, with uncertainty documented throughout decision-making and evaluation.

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