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REVIEW ARTICLE

Health Promotion for Wolbachia-Based Dengue Control: A Scoping Review of Regulatory Readiness, Community Engagement, and Communication Strategies

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ABSTRACT

Introduction: Wolbachia-based interventions have emerged as an effective strategy for reducing dengue transmission in endemic countries. However, successful implementation depends on comprehensive pre-release preparation, and evidence describing these preparatory models has not been synthesised systematically. This scoping review aimed to map and synthesise preparation models for Wolbachia-based dengue control programmes across dengue-endemic countries, focusing on regulatory preparation, community engagement, and communication strategies that facilitate community acceptance and successful implementation.

Methods: Following PRISMA-ScR and Population–Concept–Context frameworks, we systematically searched PubMed/MEDLINE, Scopus, ScienceDirect, and Taylor & Francis for 2014 to 2025 publications describing Wolbachia pre-release processes in Asia, Latin America, Oceania, and Africa. All study designs reporting regulatory preparation, mosquito production/logistics, community engagement, and communication strategies were included. Data were extracted using standardised forms and synthesised narratively and thematically.

Results: Of the 848 identified studies, 13 met the inclusion criteria. The review results identified three interacting Wolbachia programme preparations: regulatory preparation, community engagement, and communication. These domains were associated with mechanisms such as institutional legitimacy, dialogue, trust-building, informed participation, and context-sensitive communication that may support implementation readiness and community acceptance.

Conclusion: The review suggests that Wolbachia programme preparation may support community acceptance through interconnected mechanisms of institutional legitimacy, dialogue, trust-building, informed participation, community-based structures, and context-sensitive communication, although these mechanisms may vary across social and regulatory contexts. These findings provide guiding principles for future Wolbachia-based dengue control programmes in diverse settings. This framework provides practical guidance for policymakers and public health practitioners seeking to strengthen community acceptance and support sustainable deployment of Wolbachia in dengue-endemic settings.

Keywords: Community Engagement; Dengue Control; Preparation; Wolbachia

INTRODUCTION

The global dengue burden in 2024–2025 has reached historically high levels, with the Americas reporting the highest caseload to date; Brazil alone reported over 10 million cases and thousands of deaths, driven in part by the El Niño phenomenon, which causes warmer, wetter conditions that accelerate mosquito life cycles and viral replication (1,2). During the rainy season in Southeast Asia, countries such as Indonesia and India continue to face large outbreaks closely linked to transmission patterns. The World Health Organization warns that the target of a 25% reduction in dengue-related mortality by 2030 under the Neglected Tropical Diseases roadmap will be unattainable without integrated and innovative interventions (1,2).

In 2008, researchers from the World Mosquito Program (WMP) successfully introduced Wolbachia bacteria isolated from the fruit fly Drosophila melanogaster into Aedes aegypti eggs. Wolbachia can persist within the mosquito as a stable symbiont and be transmitted to subsequent generations (3). Wolbachia technology is considered a safe and environmentally friendly vector-control approach because it targets the mosquito population without known harm to other insect species or the wider ecosystem (4).

Wolbachia-based strategies offer a potentially permanent, self-sustaining solution through cytoplasmic incompatibility, wherein Wolbachia-infected males mating with wild females produce non-viable eggs, while Wolbachia-carrying females pass the bacterium to all offspring, enabling local mosquito populations to be replaced with virus-suppressing strains over several months (5,6). This approach has been validated in a cluster-randomised controlled trial in Yogyakarta, Indonesia, which demonstrated a 77% reduction in dengue incidence and an 86% reduction in hospitalisations in intervention areas (7). However, the global replication of these results depends critically on the local preparation phase, including the development of local Wolbachia lines, large-scale mosquito production, and the navigation of complex regulatory frameworks in diverse country contexts.

Research on the Wolbachia technology has demonstrated reductions in dengue incidence across multiple countries. In Indonesia, dengue incidence decreased by 77% in Yogyakarta City following the implementation of Wolbachia (7). In the United States, the prevalence of dengue decreased by up to 93% during the release period, reaching a reduction of 96% by the end of the 6th week of treatment (8). In Brazil, dengue reductions were observed after Wolbachia prevalence in Aedes mosquitoes exceeded 80% in intervention areas (4). Similarly, dengue cases decreased by approximately 40% in Kuala Lumpur, Malaysia, where the frequency of Wolbachia-infected mosquitoes was high in the intervention zones (9). In Colombia, the incidence of dengue declined by up to 73% when the prevalence of Wolbachia exceeded 60% (10). In Singapore, the incidence of dengue decreased by 56.88% during the study period (11). In Australia, the number of dengue cases decreased by 65% during the release period, followed by a 75% reduction within the subsequent 24 months (12).

International analyses of Wolbachia-based dengue-control programmes indicate that preparatory models across countries cluster around three core pillars: technical infrastructure, regulatory frameworks, and community engagement strategies. In Pacific Island countries such as Fiji, Vanuatu, and Kiribati, preparations rely on long-distance logistics involving Wolbachia-infected mosquito eggs transported from the Melbourne production facility to local laboratories for hatching; key challenges include maintaining biological quality during transit and training local staff through digital education platforms such as “Catalyst” (4,13). In high-density, populous settings such as Brazil and Colombia, the preparation model has shifted towards industrialisation, exemplified by Fiocruz’s partnership-driven construction of the world’s largest mosquito-production facility, capable of producing up to 100 million Wolbachia-infected mosquitoes per week (4). City-level preparations in Rio de Janeiro and Medellín involve highly granular geographic mapping using geographic information systems to design vehicle-based release routes, enabling rapid coverage of large urban areas (14). In contrast, Singapore adopts a highly technical population-suppression model, combining the Incompatible Insect Technique (IIT) and Sterile Insect Technique (SIT), supported by automated production facilities that use artificial intelligence (AI)-enabled sensors to sort mosquito sexes and ensure that only males are released into densely populated urban environments. Singapore also places strong emphasis on sustained public education to mitigate misconceptions regarding increases in mosquito populations during the release phase (15).

Community engagement is widely regarded as a critical yet challenging pillar in preparation for Wolbachia-based dengue control. In Vietnam, the preparation model adopts an anthropological approach to understand community concerns about the safety and efficacy of Wolbachia, with researchers spending years building trust through transparent dialogue and active resident participation in decision-making. Community support at the trial sites reached nearly 100% following intensive educational campaigns (6,16). In Sri Lanka, the COVID-19 pandemic prompted innovation in social preparation, as the World Mosquito Program implemented digital crowdsourcing challenges to solicit community-generated ideas on optimal distribution strategies for mosquito boxes, yielding culturally relevant approaches such as leveraging traditional festival networks and strengthening local ownership of the health programme (17). In Malaysia, prior regulatory experience with transgenic mosquitoes strongly influenced early preparations, where transparency in environmental risk assessment became key to securing public approval and regulatory authorisation (18).

The WMP implemented a Public Acceptance Model (PAM) to communicate and engage with communities in target areas. Across these countries, an average of 16 months of PAM implementation resulted in reported community acceptance ranging from 86% to 97% (13). In Singapore, methods included a public communication campaign and a household survey conducted by the National Environment Agency (NEA). The survey showed that 79.2% of respondents trusted the NEA regarding project implementation, and 77.4% supported the release of Wolbachia-infected Aedes mosquitoes if recommended by the NEA (6). Successful integration of Wolbachia-based interventions appears to be associated with information transparency and logistical efficiency during the preparatory phase. In settings with high government trust, such as Singapore, communities may be more receptive to Wolbachia-Aedes releases and more willing to tolerate temporary increases in mosquito numbers (19). In

contrast, perceptual barriers emerge in areas with lower health literacy or where misinformation about genetic modification persists, although Wolbachia does not directly modify mosquito DNA (5). Consequently, preparatory models that integrate robust scientific evidence with culturally appropriate narratives have proven to be the most effective in ensuring programme sustainability. The long-term implications of these diverse preparatory models are substantial.

Three components work together as an implementation readiness framework: regulatory preparation provides the foundation for governance, community engagement preparation builds social legitimacy and community participation, and communication strategy connects the two through effective information delivery and dialogue. However, the syntheses of Wolbachia-based dengue control have focused predominantly on biological and epidemiological effectiveness, and no review has integrated the pre-release phase's regulatory, community engagement, and communication dimensions within a single framework. Therefore, the available evidence remains fragmented and is not readily translatable into programme planning. To address this gap, the present review conceptualizes the "preparation model" as an adaptable implementation framework in which three interacting components operate together: regulatory preparation establishes legal legitimacy and an institutional mandate, communication builds public understanding and trust, and community engagement converts that understanding into acceptance and sustained implementation support. This scoping review will synthesise these elements to provide an adaptable framework for global health policymakers (20).

The three preparation domains can be understood through complementary social mechanisms rather than solely as components of programme readiness. By providing accessible and context-sensitive information about Wolbachia, communication strategies may support health literacy and informed understanding, while community engagement may create opportunities for participation and community voice through dialogue, consultation, and involvement of local institutions. These processes may contribute to trust and social legitimacy by enabling communities to receive credible information, express concerns, and observe institutional responsiveness. Regulatory preparation may further reinforce this process by providing visible governance structures and stakeholder accountability. However, these pathways should be interpreted as conceptual mechanisms mapped across the reviewed literature rather than established causal relationships, as most included studies did not directly evaluate the effects of these social preparation processes on implementation outcomes.

This scoping review aims to map and synthesise Wolbachia-based dengue-control programme preparation models across dengue-endemic countries, focusing on regulatory preparation, community engagement preparation, and communication strategies for building community engagement.

METHODS

Reporting framework

To ensure clarity, transparency, and reproducibility, this review was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR). The study was conducted between February and March 2026. This scoping review was registered in the Open Science Framework (OSF) under registration number 10.17605/OSF.IO/3D6QH before study selection and data extraction commenced. The review was guided by the Population–Concept–Context (PCC) framework to ensure conceptual clarity and reproducible boundaries.

Search strategy

A systematic and comprehensive search was conducted in four major bibliographic databases: PubMed (MEDLINE), Scopus, ScienceDirect, and Taylor & Francis, to identify peer-reviewed publications related to Wolbachia-based dengue-control programmes and their pre-release preparatory processes. The search was conducted in February 2026 and included studies published between January 2014 and December 2025. The search strategy combined free-text keywords and controlled vocabulary (Medical Subject Headings [MeSH], where applicable). Core search terms included "Wolbachia," "dengue," "Aedes aegypti," "community engagement," "public acceptance," "regulatory approval," "vector control," "implementation," and "pre-release preparation." Boolean operators (AND, OR) were applied to refine the search strategy, and the reference lists of eligible studies were manually screened to identify additional relevant publications. Details of the search strategy are provided below.

Selection of studies

Two reviewers (SR and FM) independently assessed all articles retrieved from the databases according to the predefined inclusion and exclusion criteria (Table 1). The screening process was conducted in three sequential stages: initial evaluation of study titles, followed by abstract screening, and finally full-text review. After completing the full-text assessment, the reviewers compared and discussed their findings. In cases of disagreement, the issue was resolved through discussion and, if necessary, by consulting an additional reviewer (TY). All excluded studies, along with the reasons for exclusion, and the final list of included articles were clearly documented and reported.

Data extraction and management

Rayyan (https://rayyan.qcri.org/) was used to organise and manage article screening. The extracted data were recorded in a standardised Microsoft Excel spreadsheet. One reviewer (SR) used a predeveloped extraction form based on the PCC framework and predefined preparatory components. Any uncertainties were discussed with a second reviewer to ensure accuracy and consistency. The extracted study characteristics included the author(s), publication year, country, study design, setting, duration, data source, and purpose. The preparatory components were mapped into regulatory preparation,

community engagement, and communication strategies. Reported barriers, facilitators, and key preparatory findings were narratively synthesised to identify patterns across studies.
The extraction form was piloted on three randomly selected studies and refined before full extraction. The single extractor (SR) received prior training in the PCC-based charting procedure. All charted data were independently verified by a second reviewer (FM); discrepancies were resolved through discussion and consultation with a third reviewer (TY).

Data synthesis and analysis

Findings were synthesised using narrative mapping supplemented by summary tables comparing preparatory components across countries. Analysis followed a combined deductive–inductive thematic approach (Braun & Clarke, 2006): an initial coding structure was derived deductively from the PCC framework and the predefined preparatory components, while additional codes were generated inductively through line-by-line reading of the extracted text. Codes were reviewed by two reviewers, grouped into candidate categories, and iteratively refined by consensus into three overarching, mutually reinforcing pillars: regulatory preparation, community engagement, and communication strategy. We did not conduct a formal critical appraisal or risk-of-bias assessment. Consistent with the descriptive mapping objective of this scoping review, the review sought to identify and categorise the reported characteristics of Wolbachia programme preparation, including regulatory preparation, community engagement, and communication strategies, rather than to evaluate the methodological quality of individual studies or determine the effectiveness of specific strategies. Accordingly, the findings should be interpreted as a mapping of the available evidence, and the reported associations should not be taken as evidence of causal effects or definitive conclusions about intervention effectiveness.
Based on the review objectives, three higher-order domains—regulatory preparation, community engagement preparation, and communication strategy—were specified a priori and were used as organising domains for data charting and deductive coding. Inductive coding was used to identify activities, subthemes, contextual variations, barriers, facilitators, and potential social mechanisms emerging from the included studies. The two reviewers independently examined and coded the included evidence, compared their coding, discussed discrepancies, and refined the subthemes through consensus. Therefore, the final synthesis distinguishes between the predefined organising domains and the inductively identified characteristics and mechanisms within and across those domains.

Table 1. PCC Framework: Inclusion and Exclusion Criteria

PCC Element	Inclusion Criteria	Exclusion Criteria
P (Population)	Stakeholders in dengue-endemic countries: local communities, health authorities, vector control agencies, and Wolbachia-based programmes	Studies lacking description of human populations or stakeholders; animal models only.
C (Concept)	Preparatory models for controlling Wolbachia-based dengue control, including regulatory frameworks and community engagement strategies	Studies solely focused on Wolbachia biology, post-release monitoring, or non-Wolbachia dengue interventions (e.g., vaccines and chemical insecticides).
C (Context)	High-dengue-incidence countries in Asia, Latin America, Oceania, and Africa (per WHO classification) over the past 11 years (2014–2025)	Studies from low-burden countries or contexts without dengue relevance (e.g., non-endemic regions)
Time and Language	Publications from January 2014 to December 2025; publications in English or publications for which an English translation was available (eligible for all study designs, including qualitative, quantitative, mixed-methods, and protocols)	Pre-2014 publications; publications not available in English or in an English translation; conference abstracts, editorials, or media reports without full data

RESULTS

Study Selection

A total of 848 records were identified through PubMed/MEDLINE, Scopus, ScienceDirect, and Taylor & Francis. After removing four duplicate records, 844 unique records were screened by title and abstract, of which 824 were excluded because they did not meet the predefined inclusion criteria. The remaining 20 full-text articles were assessed for eligibility, and seven were excluded for the following reasons: four post-deployment epidemiological effectiveness or surveillance studies, two economic or cost-effectiveness modelling without a preparatory/community engagement framework, and one public opinion study without a structured preparatory model for implementation. Ultimately, 13 studies met the inclusion criteria and were included in this scoping review (Figure 1).

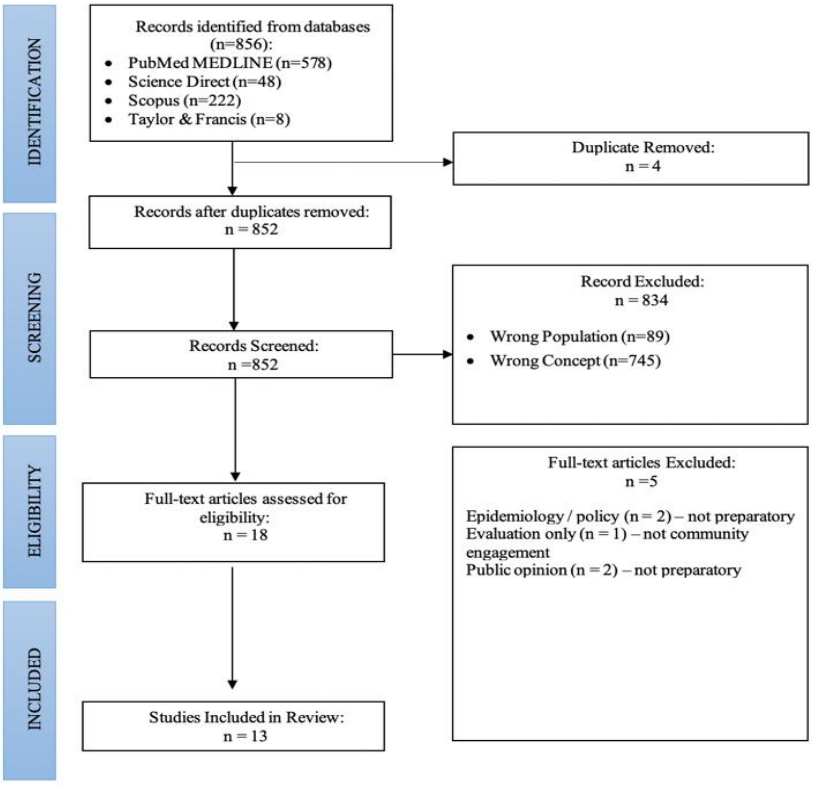


Figure 1. PRISMA flow diagram of study selection for the scoping review

Study Characteristics

A total of 13 studies conducted across Asia-Pacific and Latin America were included in this review. The majority originated from Singapore (n = 4) and Brazil (n = 2), followed by Malaysia, Vietnam, Indonesia, Colombia, Australia, Sri Lanka, and Pacific Island countries (Fiji, Vanuatu, and Kiribati). The study designs were heterogeneous, including quasi-experimental trials, cluster-randomised controlled trials, cross-sectional perception studies, qualitative case studies, and large-scale implementation descriptions. Most studies were embedded within operational Wolbachia deployment programmes rather than purely theoretical frameworks. Several studies (e.g., Brazil, Indonesia, Colombia, and the Pacific Islands) were linked to large-scale population replacement programmes, whereas studies focused on Singapore predominantly addressed strategies to suppress male-released populations. Data sources ranged from national disease surveillance systems and entomological monitoring tools (e.g., ovitraps, Gravitraps, and PCR-based diagnostics) to structured perception surveys and stakeholder consultations. The duration of the preparatory and monitoring phases varied considerably from short-term perception assessments (1–6 months) to multiyear phased deployments exceeding five years. Overall, the evidence base reflects a combination of epidemiological effectiveness studies and structured community engagement evaluations, indicating that preparatory components are often embedded within broader implementation research rather than reported as standalone frameworks (Table 2).

Because preparatory components were frequently embedded within effectiveness or entomological studies, the unit of analysis extracted from each article was the description of regulatory approvals, community engagement activities, and communication strategies rather than the study's epidemiological or entomological outcomes. Studies that reported only post-release outcomes without describing any preparatory process were excluded at full-text screening, ensuring that every included study contributed data relevant to the central concept of pre-release preparation.

Two interpretation caveats apply to the mapping shown in Table 3. First, a designation of "not reported" indicates the absence of information in the source rather than the absence of the activity in practice, and the frequency with which a component appears across studies should not be interpreted as evidence of its effectiveness. Second, the reported percentages of public acceptance are not directly comparable because they were derived from heterogeneous instruments, measurement periods, populations, and programme contexts. Therefore, they are presented descriptively rather than as pooled or comparable estimates.

The 13 studies revealed that Wolbachia pre-release preparations clustered into three interdependent pillars: regulatory preparation, community engagement, and multichannel communication, which operationalise deployment through socio-institutional mechanisms. Regulatory processes included ethics approvals and risk assessments for population-replacement programmes and centralised oversight for male-suppression programmes in Singapore. Community engagement included CRGs/PAMs, consultations, and household consent, while communication addressed misconceptions through adaptive channels. Reported facilitators included trust and early involvement, whereas barriers included concerns about genetic modification and logistical constraints. Replacement programmes emphasised sustained consent, while suppression programmes focused on managing expectations about transient increases in mosquito numbers (Table 2).

Table 2. Characteristics of the included studies

No.	Author (Year)	Country	Study Design	Study Duration	Study Setting	Instrument/Data Source
1.	Pinto et al., 2021 (20)	Brazil	Quasi-experimental study	2007–2020 (dengue); 2015–2020 (chikungunya & Zika)	Urban area in Niterói, Rio de Janeiro (divided into 4 release zones and 1 control zone)	National disease surveillance data (SINAN), mosquito monitoring system (BG-Sentinel traps), and laboratory tests (qPCR and LAMP assay)
2.	Liew et al., 2021 (15)	Singapore	Cross-sectional study (multimode survey)	May–Dec 2016	Residential areas in Singapore, specifically Braddell Heights (BH), Tampines West (TW), and Nee Soon East (NSE)	The structured questionnaires were administered through a web-based platform (QuestionPro), face-to-face surveys, and household surveys.
3.	Ong et al., 2022 (21)	Singapore	Cluster randomised controlled trial	Jun 2022-September 2024	High-rise public housing estates in 15 clusters identified as high-risk dengue transmission sites	National laboratory surveillance network (dengue case data), Ministry of Health reporting system, Gravitrap mosquito traps, and household perception surveys
4.	Arham et al., 2021(22)	Malaysia	Cross-sectional study	Nov 2017-June 2018	Klang Valley, Malaysia	A survey questionnaire with a seven-point Likert scale was used.
5.	Lwin et al., 2022 (19)	Singapore	Cross-sectional study	22 Jul–18 Aug 2021	Residential areas in Singapore (Yishun, Tampines, Choa Chu Kang, and Bukit Batok) were selected for the Wolbachia-Aedes programme.	Online survey questionnaire (FormSG) and recorded NEA public feedback data.
6.	McNaughton and Duong, 2014 (16)	Vietnam	A mixed-method case study	Jun 2009-September 2010	Tri Nguyen Island, Nha Trang, Khanh Hoa Province, Central Vietnam, Vietnam	In-depth interviews, household surveys, anonymous questionnaires, observations, workshops, and focus group-style community meetings
7.	Liew et al., 2021 (23)	Singapore	Case study	Groundwork since 2012; field trials since 2016	High-rise, high-density urban environments in public housing apartment blocks (Nee Soon East and Tampines West)	Feedback mechanisms (hotline, email, online reporting system), home visits, dialogue sessions, roadshows, and production facility tours
8.	Kolopack, Parsons and Lavery, 2015 (24)	Australia (Queensland)	Descriptive qualitative case study	Dec 2010-February 2012	Eliminate Dengue programme in Cairns (Yorkeys Knob and Machans Beach), North Queensland	Semi-structured interviews, participant observation, and internal programme document review
9.	Sri-Pathmanathan et al., 2023 (25)	Sri Lanka	A cross-sectional evaluation study	Dec 2020-Apr 2021	Nationwide in Sri Lanka, with a specific focus on mosquito release in the Colombo area.	We collected digital submissions (videos, texts, and images), online surveys, and social media metrics (Facebook, Instagram, and YouTube) were collected.
10.	Indriani et al., 2020 (26)	Indonesia	A quasi-experimental study (interrupted controlled time series)	Mosquito release: August 2016-March 2017; data analysis: 2006–2019	Yogyakarta City, Indonesia (covering 35 neighborhoods; 7 neighborhoods in the intervention area and 28 neighborhoods in the control area).	Routine dengue surveillance data (notified DHF cases) Dengue rapid diagnostic test (RDT) data from sentinel health facilities Administrative population data
11.	Velez et al., 2023 (10)	Colombia	A prospective, non-randomised, interventional study	Release: May 2017-April 2022; monitoring until July 2022	Urban areas in three adjacent cities: Bello, Medellín, and Itagüí in the Aburrá Valley, Colombia.	Egg traps (ovitraps), mosquito identification using PCR-based diagnostic tests (TaqMan), and disease surveillance data from the SIVIGILA system.
12.	Simmons et al., 2024 (27)	Fiji, Vanuatu, and Kiribati	Non-randomised intervention study (descriptive)	Release: Fiji (2018–2019), Vanuatu (2018), Kiribati (2018–2019); monitoring until 2021/2022.	Urban and peri-urban areas: Suva, Lami, and Nausori (Fiji); Port Vila (Vanuatu); and South Tarawa (Kiribati).	Egg traps (ovitraps), mosquito identification using PCR-based diagnostic tests (TaqMan assay), and community acceptance surveys.
13.	Costa et al., 2021 (28)	Brazil	Conceptual study (framework and model description)	Preparation: 2012; small-scale release: 2014; large-scale release: 2017–2019	Extensive and densely populated urban areas in Rio de Janeiro, Brazil	Public Acceptance Model, public opinion surveys, internal document audits, and mechanisms for complaint management.

Note: CRG = Community Reference Group; PAM = Public Acceptance Model; DPV = Dengue Prevention Volunteer; NIT = Nest Incubation Tray; MOH = Ministry of Health; NDCU = National Dengue Control Unit; WMP = World Mosquito Program.

Table 3. Mapping Preparatory Components in Wolbachia Pre-Release Programmes

No.	Author (Year)	Regulatory Preparation	Community Engagement	Communication Strategy	Reported Barriers	Reported Facilitators
1	Pinto et al., 2021 (20)	Approval was obtained from three agencies (ANVISA, MAPA, and IBAMA) and the national research ethics commission.	Socio-cultural analysis, community reference groups (CRGs) as advisors, and pre-release acceptance surveys were conducted.	Outreach through public schools, primary health care units, and social leadership networks	Not reported	Awareness rate: 36%–50%; independent surveys confirm public acceptance: 65%–92%
2	Liew et al., 2021 (15)	Early stakeholder consultation to identify risks and secure initial support.	Multi-stakeholder engagement, mosquito facility visits (learning journeys), and school sharing sessions	Banners, brochures (4 languages), mass media, social media, and responsive feedback system.	Underrepresentation of older age groups and certain education levels in online surveys.	High public trust in government dengue control efforts.
3	Ong et al., 2022 (21)	Approval from the Director of Medical Services and coordination with health institutions for sample collection.	Post-randomisation engagement of local political and grassroots leaders in intervention clusters after randomisation.	Health institution engagement; NEA public feedback portal; three-wave sentiment surveys.	Possible migration of wild-type mosquitoes from adjacent non-release areas	Natural/artificial boundaries (roads, water bodies) used to limit inter-cluster mosquito movement.
4	Arham et al. (2021) (22)	The Malaysian MOH and IMR provided relevant agencies with information and safety assurances.	Community willingness to participate in dengue control using Wolbachia	Emphasis on transparent risk and benefit communication to build public trust.	Public concerns about unexpected side effects on humans or the environment.	High trust in health authorities (MOH/IMR); perceived benefits outweighed risk concerns.
5	Lwin et al., 2022(19)	Not reported	Grassroots leaders and volunteers conducted door-to-door home visits to explain the Wolbachia technology.	Posters, brochures, social media, and roadshows targeting residential communities.	Perceived nuisance from increased mosquito populations in the neighborhood	High trust in implementing agencies; technology perceived as a natural method.
6	McNaughton and Duong, 2014 (16)	Coordination with committees and health departments and input on regulatory pathways.	Stakeholder mapping, community profiles, and consultations with local leaders and labor unions	PowerPoint presentations on knowledge gaps, FAQ brochures, and announcements about community loudspeakers.	Public concerns about the safety of humans, the environment, and the transmission of Wolbachia to other organisms	High trust in local health workers and strong community governance via village leaders and unions.
7	Liew et al. (2021) (23)	Ministerial-level approval supported by Singapore's existing research legislation.	Early consultation with community/grassroots leaders and formation of dengue prevention volunteers (DPVs).	Multi-channel: brochures (4 languages), infographics, live "Perspex box" demonstrations, and facility tours.	Public skepticism of mosquito release contradicts long-standing eradication campaigns	Information transparency, direct involvement of scientists in outreach, and responsive feedback mechanisms.
8	Kolopack, Parsons, and Lavery, 2015 (24)	Ethics committee approval and independent risk assessment before the first patient release.	The Independent Community Reference Group (CRG) was established to represent community views.	Door-to-door visits, local media, and provision of transparent information	Initial resident skepticism regarding the unexpected environmental risks of Wolbachia infection	Positive institutional reputation (James Cook University) and transparency in answering technical questions.
9	Sri-Pathmanathan et al., 2023 (25)	Formal partnership with the NDCU under the Ministry of Health for policy alignment.	Crowdsourcing (open call) to gather public creative solutions for programme participation.	Social media campaigns, local influencers, webinars, and celebrity endorsements.	Internet access gaps and the digital divide have limited certain population groups.	Material incentives (laptops, tablets, and certificates) and the desire of the community to address national health issues

No.	Author (Year)	Regulatory Preparation	Community Engagement	Communication Strategy	Reported Barriers	Reported Facilitators
10	Indriani et al., 2020 (26)	Approval from the FK-KMK UGM ethics committee and safety recommendations from the national technical advisory team.	Local leaders, health staff, and community volunteers were involved in conducting household acceptance surveys.	Examples include short films, brochures, posters, social media, and community exhibitions.	Not reported	High public acceptance, strong city government, and community volunteer support.
11	Velez et al., 2023 (10)	Ethics committee approval of Antioquia University; support from city and provincial health authorities.	PAM: opinion surveys, meetings with community leaders, and mechanisms of two-way communication mechanisms.	Mass media (radio, television, and social media), printed materials, educational videos, and public information booths.	Geographical challenges in densely populated hillsides: COVID-19-disrupted field activities	Community acceptance >90%; close cooperation with the local health secretary is required.
12	Simmons et al., 2024 (27)	Approval from the ethics committee and Ministry of Health approval in each country (Fiji, Vanuatu, and Kiribati).	PAM: opinion surveys, meetings with community leaders, and community consent mechanisms.	Radio, television, social media, posters, brochures, and direct sessions in schools and churches were used.	The remote island geography created logistical challenges; the measles outbreak disrupted operations.	Strong national government support and high public acceptance across all release sites
13	Costa et al., 2021 (28)	Coordinated with city (SMS) and state health authorities to align with public health policies.	PAM: Independent opinion surveys, CRG formation, and stakeholder mapping in conflict areas.	Multi-level strategy: mass media (TV, radio, newspapers), social media, school and health unit activations.	Security challenges in areas controlled by armed groups restrict team field access.	A flexible and transparent framework and close collaboration with respected local leaders are required.

Note: CRG = Community Reference Group; PAM = Public Acceptance Model; DPV = Dengue Prevention Volunteer; NIT = Nest Incubation Tray; MOH = Ministry of Health; NDCU = National Dengue Control Unit; WMP = World Mosquito Program.

DISCUSSION

The reviewed evidence suggests that the preparation of the Wolbachia programme commonly involves regulatory preparation, community engagement, and communication activities associated with community acceptance and implementation processes. Regulatory preparation may provide institutional legitimacy and governance structures, while community engagement creates opportunities for dialogue, informed participation, and community voice. Communication strategies may support understanding and address uncertainty through accessible and context-sensitive information. Together, these characteristics represent potential mechanisms through which social and institutional conditions may be considered during programme preparation. However, the available evidence does not establish that these preparation processes result in successful implementation or subsequent epidemiological impact. Therefore, reductions in dengue incidence reported following Wolbachia implementation should not be interpreted as evidence of the effectiveness of the social preparation framework, as epidemiological outcomes may reflect the effects of the Wolbachia intervention and other contextual factors rather than preparation processes alone.

Based on the literature reviewed, Wolbachia programme preparation is described through social, institutional, governance, and communication aspects. In this review, these characteristics are grouped into three priority domains: regulatory preparation, community engagement, and communication strategy. Regulatory preparation includes government and stakeholder involvement and institutional arrangements. Community engagement covers a wide range of activities, from providing information and consultation to more participatory forms of engagement where community influence is explicitly documented. Meanwhile, communication strategies involve various channels and context-sensitive approaches to convey information and facilitate dialogue. These characteristics were associated with institutional legitimacy, trust, adequate understanding, societal aspirations, and reported levels of acceptance. Acceptance surveys are primarily used to measure community views, concerns, or levels of acceptance and are distinguished from participatory engagement unless explicit evidence exists that the survey results influenced programme decisions or implementation. Overall, these findings map out potentially complementary social and institutional processes in Wolbachia programme preparation, but do not prove that interactions between these processes directly led to community acceptance, programme sustainability, or successful implementation.

The mapped activities also span a participation continuum rather than a single interaction mode. One-way information provision (brochures, posters, mass and social media) is at one end; consultation and feedback mechanisms (hotlines, public feedback portals, and opinion surveys) are at an intermediate position; and interactive participation and empowerment (Community Reference Groups, dengue prevention volunteers, and crowdsourced co-design) are at the other end.

Distinguishing these levels is analytically important: public acceptance surveys functioned primarily as measurement instruments and should not be equated with participatory engagement, and a high reported acceptance rate does not, by itself, denote meaningful community engagement (20).

The comparative pattern further suggests that engagement effectiveness was contingent on context rather than universal. High baseline institutional trust in Singapore facilitated acceptance of male-release suppression even amid transient increases in mosquito numbers; in Vietnam and the Pacific Island settings, trusted local leaders and village-governance structures were the principal conduits of legitimacy; and in Australia, Brazil, and Colombia, formalised mechanisms such as Community Reference Groups and the Public Acceptance Model provided durable two-way channels. These differences tracked underlying conditions in governance arrangements, health literacy, the history of community–government relations, the degree of technological controversy, geographic accessibility, and pre-existing communication channels, implying that the preparation model must be adapted to each setting rather than transplanted uniformly across settings.

Preparatory requirements diverge according to the biological strategy. Population-replacement strategies (e.g., in Brazil, Indonesia, Colombia, and the Pacific) release both male and female Wolbachia-carrying mosquitoes with the aim of permanent establishment. Therefore, their preparation emphasized sustained community consent, household-level acceptance, and reassurance regarding Wolbachia persistence and perceived ecological change. Population-suppression strategies (e.g., in Singapore) release only sterile males in repeated waves; therefore, their preparation prioritized managing expectations about temporary increases in mosquito numbers, clarifying that released males do not bite, and maintaining public patience across recurrent releases. Although both approaches shared a need for regulatory legitimacy and transparent communication, they differed in terms of the temporal profile and substantive content of community engagement; combining them without this distinction risks overgeneralizing the preparatory requirements of either.

Regulatory Preparation

The results of the scoping review indicate that regulatory preparation consistently involved government, regulators, research institutions, and various stakeholders before Wolbachia implementation. These findings indicate not merely an administrative process but also mechanisms for establishing institutional legitimacy derived from formal authority, so that the public may perceive the programme as a legitimate, safe, and accountable intervention. As a public health innovation involving the release of mosquitoes into the environment, the intervention may be perceived as risky. Therefore, government support, regulatory approval, and the involvement of scientific institutions can serve as institutional trust signals, indicating that the technology has undergone scientific and regulatory evaluation.

The regulatory preparation phase for Wolbachia pre-release is a collaborative process, with the continuous involvement of various stakeholders and strong government support. Regulatory preparation encompasses not only formal policy development but also the entire sectoral coordination process to ensure that interventions comply with legal and ethical standards.

Government support is crucial in ensuring regulatory preparation. This support includes data collection permits, information provision, security assurance, ethics committee assistance, and cross-sectoral partnerships. The success of the Wolbachia programme is heavily influenced by the government's commitment to integrating the programme into broader disease control policies. These findings are consistent with the World Health Organization's recommendation that the implementation of vector control technology must be preceded by strong regulatory oversight, as institutional legitimacy is a prerequisite for public acceptance (29).

Stakeholder engagement is a key element in the regulatory development phase. Stakeholders include health authorities, research institutions, environmental regulators, local governments, and community leaders. Its role is to identify risks, gain initial community support, and coordinate regulations with leaders. Stakeholder involvement from the early stages can minimise potential community resistance and increase public trust in the programmes. Thus, regulatory preparation in the context of Wolbachia implementation can be understood as an integrative process that combines policy and social aspects, where stakeholder engagement and government support are the main foundations for building a responsive, contextual, and sustainable regulatory system (24).

Community Engagement Preparation

The reviewed studies described different forms and levels of community involvement that should not be considered equivalent. Information provision activities, including education sessions, printed materials, and media communication, primarily supported Wolbachia community understanding. Acceptance surveys were used to assess community perceptions, concerns, and acceptance levels, while consultations and discussions provided opportunities for communities to express views and provide feedback. More participatory forms of engagement, such as community groups or local institutions in programme planning or implementation, provided greater opportunities for community input and, where explicitly documented, influence over programme decisions. Thus, the presence of an engagement activity alone does not indicate meaningful participation or empowerment; these terms are reserved for situations in which communities had demonstrable opportunities to shape programme decisions or implementation.

Outreach plays a role in increasing community knowledge about the Wolbachia concept, its benefits, and safety aspects. Meanwhile, home visits allow for more personal and contextual interactions, addressing specific community concerns and directly building trust (23). Furthermore, group discussions and community forums provide a space for two-way dialogue, allowing the community to express their views, questions, and concerns regarding the programme (10,14). Community leaders, such as religious or local leaders, also play a crucial role as opinion leaders who can influence broader community

perceptions and attitudes. Support from these local leaders is often a determining factor in accelerating community-level programme acceptance (13).

The formation of community groups also strengthens the sustainability of engagement by creating local structures that can serve as programme extensions in disseminating information and maintaining community participation (28). Furthermore, surveys are used to measure levels of community knowledge, attitudes, and acceptance and serve as a basis for adapting more effective and contextual communication strategies (22). This data-driven approach aligns with WHO recommendations emphasizing the importance of integrating risk communication, community participation, and ongoing evaluation in the implementation of innovation-based health interventions (29).

This is important because acceptance of health innovations may be influenced more by trust than by knowledge alone. Australians accepted the Wolbachia programme not only because they understood the technology but also because they felt involved from the outset, had opportunities to ask questions, and saw that their input influenced programme implementation (24). This phenomenon can also be interpreted through diffusion of innovation theory, which emphasises the role of interpersonal communication and opinion leaders. Community leaders can function as diffusion agents who reduce uncertainty about innovations, whereas community groups can establish social norms that may accelerate collective acceptance (30).

From a health-promotion perspective, the mapped preparation activities extend beyond the goal of achieving community acceptance. By providing accessible and context-sensitive information about Wolbachia, communication activities may support health literacy and informed understanding, while community-engagement activities can create opportunities for informed participation and community voice through dialogue, consultation, and interaction with local institutions. Reciprocal dialogue may allow programme teams to identify community concerns and adapt communication or engagement approaches to local contexts. Involvement of community groups and local leaders may provide opportunities to strengthen local capacity and agency where communities have an identifiable role in programme activities. Therefore, mutual trust can be understood as one potential mechanism within a broader process of informed participation and social legitimacy, rather than treating acceptance as the sole endpoint. However, these mechanisms represent associations and opportunities mapped across the reviewed literature rather than demonstrating the effects of specific engagement strategies.

Communication Strategy

The communication strategy used in preparation for Wolbachia programme implementation was multimodal, using various channels to reach diverse community segments. The strategy focused not only on delivering information but also on building understanding, trust, and active community involvement through a combination of conventional and digital media.

The review identified the use of various media, including brochures, posters, social media, local media, webinars, and live demonstrations. Printed media may be useful because they are accessible, reusable, and can reach community groups with varying levels of digital literacy (3,16,19). In Singapore, brochures were provided in four languages spoken by most of the population (23). Brochures were placed in schools, health units, lift lobbies in public places, and places of worship. The use of social and local media, such as radio and newspapers, also enabled broader and faster dissemination of information while allowing messages to be adapted to the local context. A social-media campaign in Sri Lanka recruited local influencers and celebrities to promote public participation (25). A media approach is important for ensuring information consistency and extending communication reach (13).

The communication strategy also includes more interactive delivery methods, such as engaging PowerPoint presentations, live demonstrations, and webinars. These activities are two-way communication activities in which the public can directly ask questions, raise concerns, and receive clarification from programme implementers. For example, live demonstrations provide a concrete visual experience of the Wolbachia process, thereby increasing understanding and reducing uncertainty or misinformation (23).

Outreach through local events, such as community meetings, religious activities, or community forums, is also a crucial part of the communication strategy. This approach leverages existing social spaces and community trust, making the message more readily accepted. Integrating communication within the local context is effective in increasing message relevance and strengthening programme legitimacy at the community level (28).

This finding suggests that communication strategies are not only aimed at increasing public knowledge but also serve to reduce perceived uncertainty, a major barrier to innovation adoption. The public tends to reject innovation when its consequences are perceived as uncertain (30). In the context of Wolbachia, this uncertainty is related to the safety of mosquito release, environmental impacts, and technology effectiveness. Therefore, using multiple communication media allows the same message to be conveyed through multiple channels, thereby increasing the information's credibility. Live demonstrations and webinars provide visual evidence of the technology, whereas face-to-face discussions allow the public to clarify any misunderstandings. This multimodal communication approach also increases the public's ability to obtain information through trusted channels.

This approach aligns with WHO recommendations emphasizing the importance of evidence-based, transparent, and sociocultural context-adapted risk communication in the implementation of innovation-based health interventions (29). Furthermore, the literature indicates that the simultaneous use of multiple communication channels can increase message delivery effectiveness and strengthen public acceptance of health programmes (24). Therefore, an effective communication strategy is measured not by the number of media used but by its ability to reduce uncertainty and build trust.

Study Limitations

This review is limited by its publication scope, which covers the period 2014–2025 and includes only English-language articles or their English translations, thereby introducing potential publication bias and reducing the representation of experiences from low-income countries or contexts with limited scientific documentation. Moreover, most studies reported preparatory components without standardised quantitative indicators, precluding a meta-analytic assessment of causal relationships between preparation intensity and dengue reduction magnitude and constraining the development of a fully standardised cross-country preparatory model.

CONCLUSION

This scoping review maps the preparatory characteristics reported across Wolbachia-based dengue control programmes and finds that they cluster into three domains: regulatory preparation, community engagement, and communication. Regulatory preparation was associated with legitimacy and an institutional framework, community engagement with trust and acceptance, and communication with effective information dissemination. These relationships represent conceptual associations identified across heterogeneous studies rather than validated causal effects, and most included studies did not evaluate social preparation components. Therefore, the evidence supports these three domains as principles to guide programme preparation, distinguishing components that were frequently reported, those regarded by implementers as important, and those associated with improved acceptance rather than a validated model demonstrated to determine implementation success. Adapting these principles to local governance, trust, and communication contexts is likely to strengthen the preparation of future Wolbachia-based dengue control programmes. From a health promotion perspective, the mapping highlights the principles of participatory communication, trust-building, and context-adapted community involvement as principles that may support informed participation, community voice, and social legitimacy. These should be distinguished from community acceptance as an outcome measure and should not be interpreted as a validated model or a guaranteed pathway to programme success.

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