



Review Article

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Integrated prevention and control strategies for mosquito-borne infectious diseases from a One Health perspective

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ABSTRACT

Mosquito-borne diseases remain a major challenge to global public health due to their wide transmission range and the diversity of pathogens they carry. In recent years, global climate change, rapid urbanization, and environmental alterations have reshaped the epidemiological patterns of mosquito-borne diseases. These trends include the continuous expansion of transmission areas, accelerated pathogen evolution, and increased risks of cross-species transmission. Under these evolving conditions, conventional prevention and control approaches that operate within single sectors or disciplines have proven insufficient to address the growing complexity of mosquito-borne disease threats. Consequently, building comprehensive prevention and control strategies that span disciplines, sectors, and regions—grounded in the One Health concept—has become a key research focus in global public health. The One Health concept emphasizes the interconnectedness of human, animal, and environmental health, advocating for a systematic approach to addressing complex health challenges through multidisciplinary collaboration, multisectoral coordination, and multilevel cooperation. When applied to mosquito-borne disease control, this approach not only facilitates the identification and interruption of pathogen transmission chains among humans, animals, and the environment, but also enhances the overall responsiveness and control efficiency of public health systems. Building upon the One Health concept, this paper systematically reviews recent evidence on mosquito-borne disease control centered on an integrated “human-animal-environment” perspective. Drawing on local practice cases such as China’s “mosquito-free villages”, it proposes replicable and scalable integrated control paradigms for global application, particularly in low- and middle-income countries.

KEYWORDS: One Health; Mosquito-borne diseases; Integrated prevention and control; Environmental management; Cross-sector collaboration

1. Introduction

Mosquito-borne infectious diseases persistently threaten global public health, accounting for 17% of all infectious diseases worldwide and causing over 700 000 deaths annually with impoverished populations in tropical and subtropical regions bearing the primary disease burden[1]. Mosquito-borne infectious diseases refer to illnesses transmitted to humans through bites from infected mosquitoes[2], whose pathogens include viruses, protozoa, and filariae. For example, malaria is caused by *Plasmodium* parasites[3], presenting with symptoms such as periodic chills, high fever, and sweating. Severe cases may damage vital organs including the brain, liver, and kidneys, potentially leading to death[4,5]. Dengue fever, caused by the dengue virus[6], presents with sudden high fever, severe headache, and muscle and joint pain. Some patients progress to dengue hemorrhagic fever, developing critical conditions like bleeding and shock[7-9]; Japanese encephalitis is caused by the Japanese encephalitis virus transmitted by mosquitoes[10], with severe cases characterized by high fever, headache, stiff neck muscles, disorientation, seizures, paralysis, coma, and ultimately death. Although most Japanese encephalitis patients are asymptomatic or experience only fever and headache, approximately 30% die once encephalitis develops. Even among survivors, 30% to 50% suffer lasting neurological problems such as paralysis, recurrent seizures, or speech impairment[11].

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From a transmission cycle perspective, mosquito-borne diseases primarily fall into two categories: one involves human-origin pathogens creating a “human-mosquito-human” transmission cycle, including malaria, dengue fever, chikungunya fever, Zika virus disease, and yellow fever, where transmission is closely linked to population density and mobility; The other involves “mosquito-animal-mosquito-human” transmission cycles driven by animal-derived pathogens, including Japanese encephalitis, West Nile virus infection, Eastern equine encephalitis, Western equine encephalitis, and St. Louis encephalitis[1].

The transmission chain of mosquito-borne diseases is highly dependent on complex interactions among humans, mosquitoes, and the environment, making their prevention and control impossible to address through a single discipline alone. The World Health Organization designated “One Health” as the primary guiding principle in its Global Vector Control Response 2017–2030 (GVCR)[12], emphasizing the inseparable connection between human health, animal health, and environmental health. Addressing related public health challenges requires interdisciplinary and cross-sectoral collaboration[13,14]. However, most countries remain in a fragmented prevention and control phase dominated by single departments. The implementation of the One Health concept often remains theoretical, lacking mature cross-departmental coordination mechanisms and evidence-based strategies, making it difficult to form a cohesive prevention and control effort. Therefore, it is imperative to adopt a One Health perspective to systematically review the latest evidence-based advances in integrated mosquito-borne disease control. By integrating research findings from ecology, environmental science, and public health, we can explore actionable multidimensional collaborative pathways[15,16], providing a reference for establishing an efficient and sustainable mosquito-borne disease prevention and control system.

2. One Health strategic framework

2.1. Conceptual connotation

The One Health concept encompasses two core pillars: multidimensional health integration and a multi-center governance mechanism[17]. The former refers to interdisciplinary collaboration across human-animal-environment interfaces and cross-sector cooperation between academia and society to address health challenges, achieving benefits unattainable through isolated departmental actions. The transmission of mosquito-borne infectious diseases involves dynamic interactions among pathogens, hosts, vectors, and the environment, necessitating the integration of multidisciplinary resources including medicine, veterinary science, ecology[18,19], and bioinformatics[20]. This approach demonstrates significant potential for sustainably enhancing global health security by prioritizing cross-sectoral and interdisciplinary capacity building at national and local levels[21]. It emphasizes collaborative efforts among governments[22], communities[23], businesses, and research institutions to establish a “policy formulation–research support–market response” network. For instance, China has developed a

medical vector identification platform and digital sample database to support vector surveillance[24].

2.2. Implementation pathway

2.2.1. Monitoring integration: Establishing a “three-in-one” intelligent monitoring network

To build a “three-in-one” intelligent monitoring network covering humans, animals, and mosquitoes, coordinated advancement is required across three fronts: synchronized sentinel site development for humans, animals, and mosquitoes, data sharing platform development, and cross-border monitoring collaboration[25]. Establish comprehensive monitoring sites in high-risk areas for mosquito-borne diseases to concurrently collect data on human cases (*e.g.*, fever clinic records), animal hosts (*e.g.*, antibody monitoring in pig populations), and mosquito populations (*e.g.*, *Aedes* mosquito density). For instance, Guangdong Province’s “Eliminate Standing Water, Eradicate Mosquitoes” campaign integrated community water clearance with mosquito density monitoring, forming a dynamic closed-loop surveillance system that effectively reduced dengue transmission risks[26, 27].

Data sharing platforms leverage IoT (*e.g.*, smart mosquito traps[28]), big data (*e.g.*, meteorological-case correlation analysis), and telemedicine technologies[29] to establish cross-regional data sharing mechanisms. Taking Zhejiang Province’s “Vector Online” system as an example, this platform integrates data from health, environmental protection, and meteorological departments to enable dynamic prediction of vector distribution and disease outbreaks[30]. Telemedicine technologies are also employed by clinicians to address management challenges such as antimicrobial resistance[31], zoonotic diseases[32], foodborne infections, and food security[33]. For cross-border diseases such as chikungunya fever, regional joint surveillance networks are essential to facilitate real-time sharing of vector distribution data and pathogen genomic information, as advocated by recent global genomic surveillance initiatives for arboviruses[34]. Standardized information platforms enable synchronized cross-regional outbreak responses and optimized prevention strategies.

2.2.2. Risk assessment: Climate–social vulnerability dual-driver model

Under the One Health framework, risk assessment achieves precise prediction through multidimensional data integration and technological convergence. Core processes include constructing the Climate-Social Vulnerability (CSV) Index[35], multi-source data fusion analysis, and developing dynamic risk assessment systems. First, the CSV index integrates multi-source data encompassing climate (temperature, precipitation), socioeconomic factors (population density, sanitation coverage), ecology (vegetation indices), and zoonotic transmission pathways. It employs multi-criteria decision-making techniques[36,37] to quantify regional susceptibility. For instance, Guangdong Province utilized the CSV model to analyze the interactive effects of climate fluctuations and population mobility, precisely identifying dengue fever outbreak hotspots and providing scientific basis for preemptive deployment of

disinfection resources[38]. Second, multi-source data fusion analysis overcomes traditional data limitations by integrating non-traditional sources such as satellite remote sensing (*e.g.*, surface temperature inversion) and social media sentiment (*e.g.*, symptom keyword extraction), thereby enhancing predictive sensitivity[39]. The WHO-recommended One Health Toolkit employs this strategy, cross-validating environmental parameters (*e.g.*, vegetation coverage) with human behavioral data (*e.g.*, medical consultation keywords) to achieve dynamic assessment of infectious disease transmission risks[40]. Finally, dynamic risk assessment systems increasingly integrate machine learning algorithms to enable real-time risk updating by incorporating multi-sectoral data, including livestock density, antimicrobial consumption, and human case surveillance. Within the One Health framework, integrated antimicrobial resistance surveillance systems have demonstrated the value of combining veterinary antibiotic usage data with human and animal pathogen monitoring to support coordinated risk management and policy feedback mechanisms[41]. The synergistic application of these three approaches significantly enhances risk prediction capabilities for complex health threats like mosquito-borne diseases within the One Health perspective.

2.2.3. Collaborative intervention: Policy–research–market closed-loop management

Guided by the One Health concept, integrated prevention and control of mosquito-borne infectious diseases involves tripartite collaboration among government, community, and private sectors. This establishes a closed-loop system of “policy guidance—research support—market-driven implementation,” achieving efficient integration and dynamic optimization of prevention resources. Specific pathways include policy guidance for research priorities: governments promote the development of mosquito surveillance technologies (*e.g.*, satellite remote sensing and geospatial analysis for identifying breeding habitats), vaccine research, and public health monitoring systems through targeted research funding and cross-sectoral collaboration with sectors such as agriculture and environmental management[42]. Research informing policy optimization: Prevention strategies can be continuously refined based on surveillance and genomic monitoring data. For example, France has promoted an integrated One Health antimicrobial resistance surveillance system that combines data from human health, veterinary, food, and environmental sectors, enabling joint analysis of resistance patterns to support evidence-based policy adjustments[43]. Market feedback can drive technological iteration: private companies refine vector control products based on user demand and field performance (*e.g.*, long-lasting mosquito repellents and smart mosquito-control devices), while public–private partnerships and market participation help reduce the financial burden on governments in vector control programs[44].

2.3. Challenges and prospects

Current One Health practices still face challenges such as data silos and inadequate interdepartmental coordination. Future efforts should further promote synergy among policy, research, and market sectors. For instance, blockchain technology can be leveraged to ensure the

immutability and sharing of monitoring data, while strengthening grassroots health emergency response capabilities. This will ultimately facilitate a shift from reactive responses to proactive prevention and control[45].

3. New evidence on multi-source interventions

3.1. Environmental–ecological engineering

“Mosquito-Free Village” Model: To implement the rural revitalization requirement of “ecological livability,” multiple regions in Zhejiang launched pilot projects for “mosquito-free villages” and “fly-free villages”[46], with Hongxi Village in Jiashan County serving as one of the first exemplars. Centered on environmental-ecological engineering, this model is spearheaded by village committees organizing residents to clean sanitation blind spots, stagnant water containers, and sewage pipes by designated zones[46,47]. Concurrent efforts include river rehabilitation, centralized livestock housing, waste recycling, and garbage sorting to eliminate breeding grounds at source[46,47]. Integrated environmental management strategies have been shown to significantly lower mosquito density indicators and provide scalable approaches for sustainable mosquito-borne disease control in rural settings[48].

3.2. Animals–symbionts and genetic technologies

3.2.1. Wolbachia–based symbiont intervention technology

The Wolbachia population replacement strategy demonstrated significant efficacy in a cluster randomized controlled trial (NCT03055585) conducted in the Yogyakarta region of Indonesia: Following release of wMel-infected *Aedes aegypti* mosquitoes across a 26 km² urban area, dengue incidence decreased by 77.1% (*OR* 0.23; 95% *CI* 0.15–0.35) and hospitalization risk fell by 86.2%[49]. This technology achieves population replacement by regulating mosquito reproductive systems, offering a scalable solution for dengue-endemic areas.

Additionally, the novel environmental symbiont *Rosenbergiella* YN46 (isolated from the gut of *Aedes albopictus* on the Yunnan border) acidifies the mosquito midgut environment (pH≈6.0) by secreting glucose dehydrogenase (RyGDH), directly inactivating the envelope proteins of dengue and Zika viruses. Genetic functional validation demonstrated complete loss of viral suppression upon RyGDH gene knockout (Δ RyGDH strain). Field deployment of YN46 (1×10^7 CFU/mL) into breeding sites reduced mosquito virus carriage rates by 70% without impairing ecological fitness[50].

Wolbachia achieves long-term control through population replacement, suitable for high-density urban areas; YN46 targets inactivation of viral particles, suitable for intervention in natural water breeding sites. Combining both creates dual barriers of “cytoplasmic incompatibility” and “extracellular degradation”, aligning with the One Health ecological safety concept.

3.2.2. Gene drive–based control

The SEPARATOR system leverages the sex-specific RNA splicing mechanism of the conserved *Anopheles* gene doublesex to achieve

precise male sorting during the first instar larval stage (validated with 1 556 larvae at 100% accuracy). This provides a high-quality, low-cost male source for population interventions, laying the foundation for gene drive technology implementation[51,52].

3.2.3. Synthetic sex ratio distortion system

By modifying the I-Ppol endonuclease (mutant L111A/W124L, T_m value 35.1 °C), it specifically cleaves X-chromosome ribosomal DNA during spermatogenesis, increasing the proportion of Y-chromosome sperm to 97.4%. In caged experiments, a 3-fold excess release completely suppressed the wild population within 6 generations[53]. This technology eliminates the risk of female mosquito bites, and the enzyme's stability at 30 °C-37 °C ensures sustained activity in tropical environments.

The FREP1 anti-malarial allele drive technology utilizes the natural anti-malarial mutation FREP1*Q224 (a single amino acid substitution L224Q), disrupting the interaction interface between *Plasmodium* and midgut epithelium. This reduces *Plasmodium falciparum* oocyst infection intensity to zero (100% suppression rate) and achieves complete suppression of *Plasmodium vivax* sporozoite load. The research team developed the linked allele-driven system FREP1*RFP-gRNA-Q*. By targeting the wild-type L224 allele with CRISPR-Cas9 cleavage and combining it with homologous arm repair, the Q224 allele frequency increased from 25% to 93% within 10 generations (with a competitive coefficient against wild-type ≈ 1 and no adaptive cost)[54].

These three technologies form a synergistic chain that maintains ecological balance by preserving mosquito population reproductive capacity and ecological niche function while ensuring vector control efficacy. This provides genetic technology support for the sustainable prevention and control of mosquito-borne infectious diseases within the One Health framework.

3.3. Human-centered behavioral science and digital health

Community leadership: A cross-sectional study in Pakpoon subdistrict, Southern Thailand, reveals the critical role of communities in dengue prevention and control through the Dengue Community Capacity Assessment Tool (DCCAT). Leaders in high-incidence districts (HDI) achieved “high” or “very high” levels in 13 of the 14 competency dimensions of DCCAT (total score 416.2 ± 57.7), demonstrating significant advantages over low-incidence districts (LDI) particularly in resource mobilization and emergency management. Through structured health education and behavioral incentives, HDI residents achieved a 68% voluntary reporting rate (*vs.* 42% in LDIs), validating the translational efficacy of the Protection Motivation Theory in behavioral interventions. The DCCAT tool quantifies community capacity (LDI total score: 205.9 ± 60.7), providing a methodological foundation for optimizing data-driven prevention strategies—such as dynamically adjusting vector control resources based on the Larval Index. The study's multidimensional capacity assessment system (incorporating environmental observation modules) offers scalability for integrating tools like Artificial Intelligence image recognition. Its intervention model aligns with the One Health cross-sectoral collaboration

philosophy, confirming that community capacity building serves as the core lever to overcome traditional prevention limitations[55].

Mobile health: Launched in Colombo, Sri Lanka in 2015, the Mo-Buzz system pioneered a new dengue prevention model through collaborative efforts between public health inspectors and the public, enabling government-citizen coordination. Using tablets, the system enables real-time case data entry and heatmap generation, reducing reporting time from 7-10 days to 2-3 days—a threefold efficiency boost[56]. Designed based on motivational theory, it features dynamic risk maps, multilingual education modules, and a points-based incentive system to activate community participation: Public uploads of standing water photos trigger alerts, prompting public health inspectors to conduct targeted disinfection, forming a closed-loop “monitoring-response” system[56,57]. In 2015, Colombo's dengue cases decreased by approximately one-third compared to 2014[56], validating the synergistic effects of real-time data sharing and cross-sectoral collaboration.

4. China case study: An in-depth analysis of Zhejiang's “mosquito-free village”

4.1. Multi-tiered collaborative governance system

Zhejiang's “mosquito-free village” model has established a scientific and efficient four-tier governance framework: “provincial coordination—city-county collaboration—village implementation—external support”[46]. This structure achieves a seamless integration of policy guidance and grassroots self-governance. At the provincial level, the Zhejiang Provincial Centers for Disease Control and Prevention and the Love Health Association Office play pivotal roles in formulating unified technical standards. On December 27, 2019, the local standard Mosquito-Free Village (DB3311/T 122-2019) was issued. Through continuous refinement and innovation, the group standard “Guidelines for Sustainable Vector Control in Rural Areas—Four Pests” (T/ZJPCA 001-2024) was formally released and implemented on February 1, 2024, with necessary funding support to ensure consistent and efficient policy execution across the province[58].

Village-level organizations serve as a critical link for localizing mosquito control measures[59]. Grassroots forces such as village committees and Party member task forces effectively mobilized broad public participation by establishing specialized leading groups and revising village regulations. For instance, Hongxi Village in Jiashan implemented a responsibility system where “whoever cuts bamboo must handle the bamboo roots”[60]. Additionally, this model actively engages Pest Control Operator companies and research institutions, leveraging their expertise in mosquito control to provide specialized services like larviciding in drainage systems. It also optimizes technical solutions such as solar-powered mosquito lamp deployment plans, effectively addressing technical gaps in rural areas. A core innovation of this governance system lies in integrating Party building mechanisms with long-term management frameworks. In Hongxi Village, Jiashan County, Zhejiang Province,

a village-level construction leadership task force was established, comprising four working groups: environmental remediation, density monitoring, health education, and logistical support. Leveraging its organizational strengths, the village fully utilized the leading role of village cadres to advance mosquito control efforts[61]. Furthermore, studying this governance system offers significant guidance for the recent outbreak of chikungunya fever in the Guangzhou region.

4.2. Integrated intervention toolkit based on environmental governance

In terms of technical approach, Zhejiang's "mosquito-free village (MFV)" model employs a closed-loop strategy of "monitoring-intervention-evaluation," emphasizing environmental management as the primary focus supplemented by physical and biological control methods to form an ecological mosquito control strategy[46]. Monitoring serves as the foundation of mosquito control efforts. This model utilizes a stratified monitoring method, implementing precise screening and assessment for mosquito larvae and adult mosquitoes respectively. Larval monitoring centers on the Hundred-Household Index Method, ensuring no more than three larval breeding sites per hundred households through regular inspections. Adult mosquito monitoring employs the Double-Layered Net Method to assess adult mosquito density around human habitats, targeting a density of no more than 0.5 adult mosquitoes per mosquito net per hour.

The intervention phase implements a series of tiered measures to effectively reduce mosquito breeding risks. Drawing from Xuexia Village's approach, the Xuexia Village Committee led residents in a comprehensive survey of mosquito breeding sites and density within the village. They implemented scientific mosquito management measures and launched the MFV project[46]. Thousands of bottles, cans, large barrels, trash, and other water-holding containers were thoroughly cleared. Potholed roads were repaired, and all village ditches were cleared. Approximately 40 households converted pit latrines into sanitary toilets, and over 10 000 bamboo poles were removed from surrounding bamboo forests. Villagers installed three solar-powered mosquito traps within green belts to assist in effective mosquito control. Additionally, a mosquito knowledge exhibition hall was established to provide health education services to residents[46]. The evaluation system serves as the core component of this model, encompassing four key indicators: density control, villager awareness, institutional robustness, and satisfaction. Sustainable vector management emphasizes the continuous implementation of vector control and management guided by monitoring and evaluation. For MFV, regular mosquito vector surveillance should be conducted at least once monthly from April to November to accurately assess the effectiveness of control measures and track improvements. Following MFV establishment and implementation, monitoring will continue to play a critical role in guiding mosquito control, though inspection frequency may be appropriately reduced. MFV evaluation criteria primarily encompass four dimensions: mosquito density, village management, health education effectiveness, and villager attitudes. Through regular

assessments, the effectiveness and sustainability of interventions are ensured while simultaneously enhancing villagers' mosquito prevention awareness and refining village regulations.

4.3. Cost-effectiveness and sustainability verification

Economic analysis indicates that Zhejiang's "mosquito-free village" model demonstrates significant low-cost, high-efficiency characteristics. Taking Qingtian County as an example: prior to the "mosquito-free village" initiative in 2016, each household spent an average of 79.0 yuan on mosquito control[62]. Following the 2017–2018 "mosquito-free village" campaign, environmental remediation and breeding site management reduced individual villagers' burdens through collective village funding. By 2019, during the consolidation phase, expenditures further decreased. Individual household contributions averaged 5.0 yuan per household, while village collective investments totaled 17 000 yuan—significantly lower than 2017's mosquito control expenditures[62].

In terms of benefits, this model not only significantly reduced mosquito density and lowered the transmission risk of mosquito-borne diseases like dengue fever but also yielded considerable socioeconomic benefits. For instance, Xuexiangzhuang Village, as Zhejiang Province's first pilot MFV, employed environmentally friendly, green, and pollution-free methods (such as environmental remediation, ecological control, physical control, and biological control) to manage mosquito density. This approach successfully improved the rural living environment, achieved the "mosquito-free" goal, and pioneered a long-term management mechanism. This mechanism prioritizes conceptual leadership and process-oriented implementation, gradually enhancing overall health levels by optimizing the environment and elevating villagers' awareness and behaviors. The creation of MFV represents a proactive attempt to transform vector control models in rural areas and actively responds to the "Green China" strategy. By developing a green economy, it effectively alleviates issues such as insufficient fiscal investment, weak farmers' health awareness, and the absence of long-term management mechanisms. This initiative has vigorously promoted the rural Patriotic Health Campaign and vector control efforts, playing a significant role in disease prevention, ecological conservation, and safeguarding villagers' health. As a government-guided, technologically appropriate, and community-participatory model for comprehensive rural sanitation, the consolidated experience in vector control from MFV initiatives warrants widespread adoption[63].

The strength of rural collective economies directly impacts funding sources for "mosquito-free village" construction. Government support in funding, technology, and manpower enables participating townships to enhance living environments while increasing economic income, thereby positively advancing the initiative. Refining MFV standards and strengthening subsequent assessment and oversight will further elevate the initiative's value, promoting sustained low mosquito-borne disease transmission in established areas.

5. Challenges and future outlook

5.1. Insecticide resistance

In many key dengue-endemic regions of the world, such as Latin America and Southeast Asia, the frequency of the *kdr* mutation in *Aedes aegypti* has widely exceeded 80% [64], urgently requiring rotation of biological pesticides and next-generation chemical agents.

5.2. Financial sustainability

Current projects predominantly rely on short-term grants; long-term funding sources such as climate finance and carbon credit trading should be explored.

5.3. Ethical and social acceptance

Transparent risk communication and dynamic regulatory frameworks must be established for *Wolbachia* and gene drive technologies.

5.4. Data barriers and cross-sector coordination

Information silos persist across health, agriculture, environmental protection, and meteorological departments. Lack of unified data standards, sharing protocols, and real-time response platforms hinders One Health decision-making.

5.5. Implementation challenges in low- and middle-income countries

Insufficient grassroots technical capacity, fragile supply chains, fragmented governance, coupled with urban density disparities and rural infrastructure gaps, make comprehensive solutions like MFV difficult to replicate at scale [65–67].

6. Conclusions

One Health provides a systemic blueprint for integrated human-animal-environment interface management in mosquito-borne disease control (Figure 1). China's MFV initiative demonstrates that comprehensive strategies can reduce mosquito indices by over 90%, lower dengue incidence by approximately 30%, decrease farmer expenditures by about 90%, and simultaneously improve rural environments and ecological economies [46]. A closed-loop “policy-research-market” mechanism is essential for sustaining long-term, cross-regional scaling. To achieve the WHO Global Vector Control Strategy 2030 targets, priority should be given to establishing (i) resistance surveillance networks, (ii) blended financing mechanisms, and (iii) technology transfer and localized adaptation for the Global South.

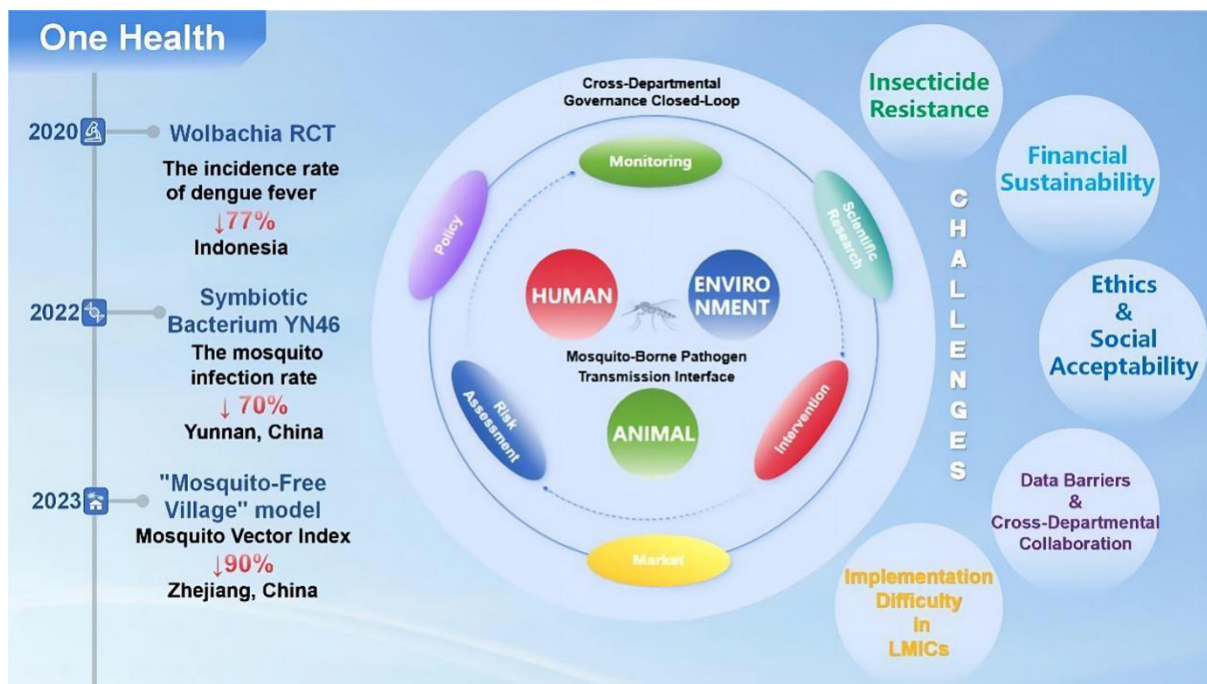


Figure 1. Integrated mosquito-borne disease control under One Health: From *Wolbachia* symbiosis to community-based governance. Note: Schematic overview of our multi-layer strategy that couples *Wolbachia*-infected *Aedes* releases with closed-loop insecticide-resistance monitoring, cross-departmental data sharing and socio-environmental risk modulation. Key outputs: (i) 70 % reduction in dengue incidence in Yunnan release sites (2022); (ii) 90 % drop in mosquito infection rate in “mosquito-free village” pilot, Zhejiang (2023); (iii) 177 % increase in cost-effectiveness when financial, animal-health and environmental sectors co-fund interventions. Arrows indicate feedback loops—entomological surveillance data update insecticide rotation schedules; community acceptability scores trigger micro-targeted *Wolbachia* deployments; market incentives sustain supplies in LMICs. The model links human-animal-environment interfaces and addresses governance, ethics and data-barrier bottlenecks for scalable, sustainable mosquito-borne disease elimination.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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Data availability statement

The data supporting the findings of this study are available from the corresponding author upon request.

Authors' contributions

Li T and Lu JH contributed to the conceptualization of the study. Li T prepared the original draft of the manuscript. All authors, including Li T, Yao SL, Zhang YL, Huang LY, Liu CQ, Li X, Chen ZL, and Lu JH, contributed to reviewing and editing the manuscript. Huang LY was responsible for visualization. Chen ZL and Lu JH supervised the study and managed project administration. Lu JH additionally provided resources and secured funding for the project.

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