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Case Study

Health Communication Strategies for Wolbachia Mosquito Implementation in Dengue Prevention: A Case Study in Bontang City

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ABSTRACT

Dengue Hemorrhagic Fever (DHF) remains a serious public health issue in Indonesia. One of the innovations developed to reduce the number of DHF cases is the implementation of Wolbachia-infected Aedes aegypti mosquitoes. This study aims to describe and evaluate the health communication strategies used in the implementation of Wolbachia mosquitoes in Bontang City, East Kalimantan The study employs a qualitative case study design, using four Focus Group Discussions (FGDs) with 32 participants, including community health volunteers (cadres, i.e. community health volunteers), household foster parents, sub-district officials, and health center staff. Thematic analysis was conducted with source triangulation to ensure data validity based on community perceptions, the socialization process, implementation challenges, and stakeholder support.. The results indicate mixed outcomes: positive acceptance was initially supported by trust in health workers, clear explanations of Wolbachia's biological role, and active involvement of community volunteers; however, several obstacles reduced support, including ongoing dengue cases, perceived increase in mosquito populations, misinformation and hoaxes on social media, weak cross-sector coordination, and cadre turnover without transition. Discontinuous communication strategies weakened the effectiveness of health message delivery to the community. Strengthening risk communication, broader public campaigns, and routine cross-sector evaluations are needed to ensure the program's sustainability.

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INTRODUCTION

Dengue fever (DF) continues to pose a major public health problem across tropical and subtropical areas. According to Hattetal, as referenced by Wongkar, Yudi Emili, Fentje Langitan, and Agusteivie Telew (2024), it is estimated that roughly 390 million people are infected with dengue each year, with about 96 million cases showing clinical manifestations of differing severity.[1] The disease is transmitted through the bite of the *Aedes aegypti* mosquito and can lead to severe symptoms or even death if not treated promptly and appropriately. Dengue prevention still heavily relies on vector control, as there is currently no widely effective vaccine or medication available to comprehensively combat dengue infections.[2]

At the national scale, Indonesia's Ministry of Health has introduced multiple approaches to combat dengue fever, including the release of *Aedes aegypti* mosquitoes infected with Wolbachia—a naturally occurring microorganism shown to suppress dengue virus replication. Yet, the effectiveness of this biological method relies heavily on effective health communication,

as limited information exists regarding how communities in Bontang perceive and respond to such an intervention. This knowledge gap forms the basis of the current study.[3] This innovation aims to reduce dengue transmission in a sustainable and environmentally friendly manner. The program has been piloted in several regions of Indonesia, including Yogyakarta, and is now being expanded to other areas, including Bontang City in East Kalimantan Province. In its implementation, the success of this program is not only determined by biological and technical aspects, but also strongly influenced by the effectiveness of health communication strategies that support community acceptance and participation.

Successful health communication demands a thorough grasp of the audience's traits, the selection of suitable communication channels, and message delivery that resonates with the community's social and cultural setting.[4] In the context of dengue prevention, the innovation of using *Aedes aegypti* mosquitoes carrying *Wolbachia* bacteria has been proven to reduce the replication rate of the dengue virus within the mosquito's body, thereby lowering the potential for disease transmission.[5] However, the success of such technology-based programs largely depends on participatory and adaptive risk communication strategies, especially when dealing with uncertainty and public concerns.[6] Therefore, active community involvement from the planning to the implementation stage becomes a key factor in enhancing the effectiveness of communication and the sustainability of health programs.[7]

Bontang City has adopted the Wolbachia-infected mosquito initiative as part of its dengue control strategy. The program is carried out through cross-sectoral cooperation involving the health department, community health centers (*puskesmas*), sub-district offices (*kelurahan*), health cadres, and community foster parents (OTA). While the effort initially received broad support, a number of obstacles have surfaced during implementation. These include the spread of misinformation and hoaxes that fuel public resistance, limited community understanding of the Wolbachia concept, logistical issues in bucket distribution and monitoring, and inadequate coordination among stakeholders.

The most pressing challenge lies in declining public trust and participation, driven by inaccurate information and the limited reach of health communication efforts capable of engaging all population groups. Additional problems such as uneven bucket distribution, on-the-ground technical constraints, and difficulties in reporting and evaluation further hinder the program's long-term sustainability.

Previous studies have empha sized the importance of community engagement and communication in the successful implementation of the Wolbachia mosquito program. Research conducted in Yogyakarta demonstrated that strong support from well-trained health cadres and foster parents (OTAs) significantly enhanced public acceptance of the program.[8] The study in Buleleng concluded that ineffective leadership, unclear regulations, low community participation, and weak evaluation and coordination among stakeholders can hinder the success of the Wolbachia program.[9]

Based on this background, this study aims to describe and evaluate the health communication strategies used in the implementation of the Wolbachia mosquito program in Bontang City, and to identify the various factors influencing the program's success or failure from the perspectives of both the community and local policymakers.

CASE DESCRIPTION

This study employs a qualitative approach with a case study design to explore the dynamics of implementing the Wolbachia-infected mosquito program as a dengue fever (DF) prevention strategy in Bontang City, East Kalimantan. This approach was chosen to gain an in-depth understanding of the experiences, perceptions, and participation of field actors and community members regarding an innovative and relatively new program in Indonesia.[10] The case study approach allows researchers to gain a deep understanding of the social context and unique experiences in the implementation of health policies.[11] Furthermore, the use of focus group discussions (FGDs) is effective in exploring group dynamics and collective perceptions in the implementation of community-based programs.[12] These methods are particularly relevant for

examining the complex interplay between community perceptions, institutional coordination, and communication strategies in the field.

Data collection was conducted through four Focus Group Discussions (FGDs) with a total of 32 participants, including community health volunteers (cadres), household foster parents, sub-district officials, and health center staff. The FGDs were held in four sub-districts representing coastal and urban areas, ensuring diversity of perspectives. Data analysis employed thematic analysis with coding, categorization, and theme construction, and rigor was maintained through source triangulation and cross-validation. The FGD informants were individuals directly involved in the program's implementation or affected by the presence of Wolbachia-infected mosquitoes in their environment. Through this method, data were collected exploratively to reveal the social, technical, and communication dynamics that occurred throughout the program implementation period.[13]

The study was conducted in several sub-districts across Bontang City, including coastal areas such as Bontang Kuala and Guntung, as well as other regions representing the program's distribution coverage. These areas possess diverse demographic, geographic, and community acceptance characteristics, thus providing a comprehensive overview of the challenges and successes in implementing the Wolbachia mosquito program. The site selection also considered the presence of active OTAs and cadres, as well as documented dengue case reports before and during the program implementation.

Data analysis was conducted using a thematic analysis approach, which involved identifying patterns of meaning, categories of findings, and main themes emerging from the FGD transcripts.[14] This process included open coding, grouping codes into categories, and constructing overarching themes that represent the key issues in program implementation. Data validity was maintained through source triangulation by comparing narratives from informants with various backgrounds and validating the analysis results with field documentation.[15]

The main focus of this study is to describe public perceptions of Wolbachia-infected mosquitoes, trace the program's communication and outreach process from health officials to the household level, and identify field-level implementation challenges. In addition, the study also examines the effectiveness of the health communication strategies used and the extent to which support from both formal and informal policymakers contributes to the program's success or hindrance.

Table 1. Participant Characteristics Table

Participant Group	Number	Characteristics / Role
Community health volunteers (cadres)	12	Female, 25–50 years old; responsible for container care and socialization
Household foster parents (OTAs)	10	Community members hosting containers at home
Sub-district officials	5	Local government representatives
Health center staff (puskesmas)	5	Surveillance and health promotion staff
Total	32	Across 4 FGDs in coastal and urban areas

RESULTS

Initial Perceptions and Understanding

At the outset of the Wolbachia-infected mosquito initiative in Bontang City, most community members, health cadres, and foster parents (OTAs) showed a generally favorable reception to the program. This was reflected in a solid basic understanding of the Wolbachia mosquito concept, particularly among health cadres who had participated in outreach and training sessions organized by the community health centers (*puskesmas*) and the Health Department. Their knowledge primarily focused on the fact that *Aedes aegypti* mosquitoes carrying the Wolbachia bacterium can suppress dengue virus transmission and pose no threat to human health.[16]

One of the health cadre informants shared that people in her area generally accepted the presence of the Wolbachia mosquitoes and understood their purpose. "The role of Wolbachia mosquitoes is to reduce dengue fever cases in Bontang City," said a cadre (A1), emphasizing the clear public health goal behind the mosquito release. A similar understanding was expressed by another informant: "Wolbachia is a mosquito that has been given a bacterium naturally found in insects, and the goal is for this bacterium to gradually neutralize the dengue virus," (R2, cadre). Such technical knowledge indicates that the initial outreach efforts successfully conveyed the core message about the biological benefits of Wolbachia in breaking the dengue transmission cycle.

Further understanding was demonstrated by a sub-district official who explained the mechanism of how Wolbachia-infected mosquitoes work. A local official explained, "Wolbachia is a bacterium implanted in *Aedes* mosquitoes. It's mosquito versus mosquito. When a Wolbachia-infected mosquito mates with a regular *Aedes*, the resulting offspring are weakened, preventing the transmission of dengue," (R6, Sub-district Office). This narrative shows that even at the policymaking level, there was a reasonably deep comprehension of the scientific principles underpinning the program.

Positive support also came from OTAs who voluntarily accepted and cared for buckets containing Wolbachia-infected mosquito eggs placed in their neighborhoods. One OTA expressed trust in the program's safety, even when her young child was near the mosquitoes. "There are many benefits. As a cadre, I tell people these are good mosquitoes; it's okay if they bite. When I work, my two-year-old is with me, and he often gets bitten. I know it's not a problem," (A1, cadre). This indicates acceptance not only rooted in knowledge but also in trust toward the program and its implementers.

The community's initial enthusiasm was also evident in how they responded to the cadre's explanations during the first socialization events. "We explained to them about mosquito development, but that these were good mosquitoes. They asked, 'What do you mean by good mosquitoes? They all bite.' So we explained," (A4, cadre). The communicative approach taken by health cadres seemed effective in reducing initial resistance and building a more positive understanding.

In areas such as Gunung Telihan, community acceptance was reported to be very high. A staff member from the sub-district office shared, "In Gunung Telihan, thank God, the reception was good. There was also an increase in knowledge. We gave guidance, and they accepted it," (A9, Sub-district Staff). This success suggests that with appropriate communication, public support can be gained even for technically innovative programs such as this.

Communication and Outreach Strategy

The communication strategy for the Wolbachia-infected mosquito program in Bontang City employed a structured, multi-level outreach approach. Information dissemination started from the Health Department, then moved to community health centers (*puskesmas*), sub-district offices (*kelurahan*), and neighborhood units (RT), and was further shared in social settings such as neighborhood mothers' gatherings and religious groups. This method aimed to ensure that messages about Wolbachia mosquitoes reached every segment of the community through well-regarded and trusted local figures.

One cadre informant explained that before the program was implemented in the field, socialization had already been conducted by the Health Department to explain how Wolbachia mosquitoes work. "Before we went down, there was socialization from the Health Department explaining how it works," (R4, cadre). In addition, the puskesmas staff were actively involved in disseminating information to the community. "There are two people from the puskesmas who do socialization for Wolbachia. Sometimes the health promotion team is also involved," (A5, puskesmas surveillance staff), indicating that cross-program involvement was also done at the early stage of the program.

Socialization was also carried out through local community forums, as explained by one OTA: "There are regular mothers' meetings at the RT level. The kelurahan invites the puskesmas to do socialization. The mothers then convey the information to the residents. If some residents remain stubborn, we convey it again," (A3, OTA). This strategy shows a layered approach that

relies on the strength of existing social structures to broaden the message's reach.

However, the effectiveness of this strategy declined over time. Several informants revealed that socialization was only conducted once at the beginning of the program. "The counseling was only done once at the start," (A4, cadre). The lack of periodic reinforcement made the community vulnerable to misinformation and rumors.

A major challenge in the communication strategy arose when hoaxes or false information regarding the dangers of Wolbachia mosquitoes spread, especially on social media. The emergence of narratives that discredit the program, even from figures with health backgrounds at the national level, significantly impacted public trust. "At first, people accepted it, ma'am, but when the hoax appeared, they were influenced. They got angry, asking why mosquitoes were being bred again when there were already many mosquitoes. My own RT refused," (A4, cadre).

The circulating hoaxes not only triggered rejection but also increased negative stigma against the cadres and OTAs involved in the program. One cadre stated, "When Wolbachia was launched in Bontang, there were many issues about Wolbachia, and it was difficult for us. These issues came from highly educated people. We, as cadres, had to work extra because many OTAs and community members were influenced by these issues," (R2, cadre). Moreover, an informant from the kelurahan added that one of the most impactful sources of hoaxes came from a former national health official. "During several FGDs, many of the issues raised came from Siti Fadilah Supari. Even the health ministers have different perceptions, let alone us at the kelurahan level," (R6, kelurahan).

The impact of these hoaxes was quite broad. Many people who initially supported the program then changed their stance to reject it. "At first, everyone accepted it well. After the TikTok issue, many rejected it," (R9, OTA). In some cases, cadres reported having to face direct anger and rejection from residents and community leaders. "We were scolded, ma'am. We got a hard time," (A7, cadre).

The response to these challenges was carried out through re-socialization efforts, persuasive approaches by cadres, OTAs, and kelurahan staff, as well as direct clarifications to the community. However, informants stated that these strategies were not fully able to keep up with the speed and reach of negative information spreading rapidly through social media. Some informants suggested the need for a more massive and structured national campaign to counter hoax narratives and strengthen public trust. "We are optimistic but need more promotion. Once hit by a hoax storm, it's difficult. It would be better to have public service announcements on TV because this is a national issue. This program is from the Ministry of Health, so the Ministry should promote it nationally," (R6, kelurahan).

Field Challenges

Although the implementation of Wolbachia-infected mosquito program in Bontang City initially received fairly positive responses, various challenges emerged over time. One of the main challenges in the field was the occurrence of dengue fever cases in several areas despite the Wolbachia mosquito program being underway. This led to negative perceptions among the community that the program was ineffective or even worsened the situation.

Several community "foster parents" (OTA) explicitly expressed rejection after their families or neighbors contracted dengue. "If they get cases or their family members get dengue, they don't want it, ma'am. If their child gets dengue, they immediately reject it, refusing to have the mosquito breeding containers installed. They say it's because of your mosquitoes" (A7, cadre). In some other cases, the community perceived that the presence of the containers actually increased mosquito populations, without understanding that Wolbachia mosquitoes do not transmit dengue. "Many were surprised, saying the mosquitoes increased" (A1, cadre), said one cadre describing the spontaneous reaction of the community to the rise in mosquito numbers around the containers.

Health misinformation, particularly hoaxes circulated via social media, can significantly reduce the effectiveness of public health programs if not countered with timely and credible clarification efforts.[17] In this context, the success of health communication is highly dependent on the credibility of the communicators involved and the level of public trust in the implementing institutions.[18] Therefore, managing public narratives and maintaining institutional trust must

become integral parts of any communication strategy, especially when introducing new biotechnological interventions such as the Wolbachia mosquito program.

The community's inability to physically distinguish between wild Aedes aegypti mosquitoes and Wolbachia-infected mosquitoes further reinforced the perception that the program increased disease risk. One OTA expressed doubt: "That's why there are so many mosquitoes. From my understanding as a worker, we are confused whether the ones biting are good mosquitoes or not" (R3, OTA). Due to such perceptions, some OTAs reduced the number of containers they accepted or rejected them altogether.

Another significant obstacle affecting program sustainability was the spread of nationwide hoaxes that swayed public opinion negatively against Wolbachia mosquitoes. This misinformation was amplified by prominent figures with health backgrounds who were widely known, causing a substantial psychological impact. One cadre noted, "At the start of Wolbachia in Bontang, there were many issues about Wolbachia... Those issues came from highly educated people. We as cadres had to work extra because many OTAs and community members were influenced by those issues" (R2, cadre). The hoax impact also created a tense emotional atmosphere in the community. "We got scolded, ma'am, got reprimanded," (A7, cadre) said a cadre describing the strong rejection from residents.

Other problems included weak coordination among implementing agencies in the field, especially during the transition of cadres from larva inspectors or health cadres to members of Saka Bakti Husada (SBH), a youth student group. This transition lacked proper mentoring systems and effective communication to both the local village officials and the community. "Before going to the community, we (kelurahan officials) were included. When cadres were replaced by SBH, many residents did not understand what Saka Bakti Husada was. There were school-uniformed kids gathering the containers; people wondered what that was. If we weren't informed, we couldn't notify the neighborhood leaders (RT)" (R4, cadre). This caused confusion among the community and even lowered the program's credibility because it appeared unprofessional.

The cadre transition also resulted in the loss of several containers due to the absence of well-documented location data. Some containers were found to have been repurposed since they were not monitored. "Our problem is we don't know the container locations, unless the old cadres showed the location via video call. The containers became paint buckets, flower pots, or betta fish tanks" (R4, SBH cadre). Additionally, SBH cadres lacked sufficient communication skills to explain the program to the community. "SBH cadres are young kids; not all water is replaced regularly. Sometimes the water turns green and isn't changed. The SBH cadres don't inform when finished. The OTA asks me" (R10, cadre also acting as OTA).

Poor coordination was also evident in the lack of cross-sector involvement and communication between cadres and the health center or health office. One cadre stated, "If there were findings in the field, there should be coordination with the health center. Only after six months did the health promotion unit at the health office realize there was a problem and felt they had not been informed" (R4, cadre). This indicates a significant communication gap between implementing agencies.

The Role of Cadres and Foster Parents (OTA)

Cadres and foster parents (OTA) are two key elements in the successful implementation of the Wolbachia mosquito program in Bontang City. Both play a direct role in the distribution, maintenance, and monitoring of the mosquito population in the field. However, the reality on the ground shows that the workload carried by the cadres often exceeds their capacity, while the OTAs require more intensive guidance to be able to perform their roles optimally.

In the context of this program, health cadres are not only responsible for conducting outreach but also for distributing mosquito eggs, changing the water in the containers every two weeks, and counting pupal cases to evaluate the mosquito population. They must also maintain active communication with the OTAs and submit reports to the community health center (puskesmas) or the village office (kelurahan). "My role and task is to replace the Wolbachia mosquito eggs every two weeks. I am responsible for 35 containers. We have 11 cadres, averaging 35 containers each. Most of mine are at schools. Schools are also included" (A1, cadre). This task

demands discipline and high mobility, especially when the container locations are far apart or situated in hard-to-reach areas.

Nevertheless, most cadres complain about excessive workloads because they also serve multiple other roles, such as cadres for posyandu (integrated health posts), PKK (family welfare movement), and jumantik (mosquito larvae monitoring). "Cadres in Bontang City are also posyandu cadres, PKK cadres, and others, so they are overwhelmed with reports from multiple programs" (R4, cadre). This situation is further worsened by delayed honorariums, which should serve as recognition for their dedication. One cadre stated, "Regarding cadre honorariums, we were first paid after 6 months. It's a contract system; initially, we received 800,000 rupiahs for 3 months, then it decreased. They said it was due to budget differences. I asked why it decreased when the workload increased" (R10, cadre). The mismatch between workload and compensation risks lowering motivation and work quality among cadres in the field.

Meanwhile, OTAs who receive containers with mosquito eggs also face their own challenges. They are essentially only asked to care for and maintain the containers, but in practice, they often have to take the initiative to solve technical problems like water shortages, spilled containers, or ant infestations. "I think the container should be placed a bit higher so ants don't get in" (A3, OTA). However, when a container spills, OTAs have to wait for cadres to visit two weeks later because they do not have backup egg stocks. "OTAs are only entrusted with and maintain the containers. If the container spills, they have to wait for the cadre visit two weeks later to refill. We don't have egg stocks" (A4, cadre).

The availability of clean water is also a significant technical problem. In some locations, especially in office areas or dense residential neighborhoods, water is difficult to access, so cadres have to bring their own water to replace the container's contents. "The challenge is when the houses are far and water is hard to get, we have to carry big water bottles to fill the containers. Like in office areas" (A4, cadre). This adds to the physical burden and time commitment required from the cadres.

Additionally, the distribution of containers to OTAs' homes is not always even. When some OTAs refuse, the containers are often concentrated at the cadres' houses or specific points. This causes an imbalance in the spread of Wolbachia mosquitoes, which theoretically can reduce the program's effectiveness. "Many containers pile up in one grid because when OTAs refuse, the containers are taken to the cadre's house and hatched there. This is good, but the distribution is uneven" (R4, cadre).

Support and Evaluation

Institutional Support and Evaluation Mechanisms are important factors in ensuring the continuity and effectiveness of the Wolbachia mosquito program implementation. During the initial phase, cross-sector coordination and routine evaluation activities ran quite well. The Health Office, through community health centers (puskesmas), actively held special meetings to evaluate the program's progress, especially during the first three months. One puskesmas staff member said, "In the first 3 months, evaluations were held twice a month. After that, it was adjusted" (A5, puskesmas staff). This early evaluation served as an important forum for monitoring, reporting obstacles, and strengthening communication strategies with the community.

However, the frequency and regularity of evaluations declined over time. Several informants mentioned that after the initial quarter, there was no fixed evaluation schedule. Meetings were only held when deemed necessary or when problems arose in the field. "There is no evaluation forum. The only forums are those held by the puskesmas or the public works department. These are for the Wolbachia cadres" (A7, cadre). This irregularity impacted coordination, motivation, and the cadres' ability to respond quickly to changing situations.[19]

An important issue that emerged was the uneven distribution of information among implementing agencies. The kelurahan (village administrative unit), as the frontline in social approaches to the community, reported not receiving updated dengue fever case data from the puskesmas, despite the data's importance for evaluating program effectiveness. "We have not gotten a clear picture that Wolbachia mosquitoes do not transmit dengue. The data on cases (before and after) is at the puskesmas, but we at the kelurahan are not aware" (R6, kelurahan

staff). Community perception is heavily influenced by narratives about disease case reductions that can be supported by data. When the data is not communicated, it creates the impression that the program has no positive impact, which ultimately reduces public trust.

The incomplete involvement of kelurahan was also evident in a cadre's statement noting that when cadres were replaced from health cadres to Saka Bakti Husada (SBH) youth members, the kelurahan was not officially informed. "When the cadres were replaced by SBH, many residents didn't understand... if we weren't told, we couldn't inform the neighborhood heads (RTs)" (R4, cadre). This reveals weak information flow between the health sector and local government apparatus, even though support from local leaders and structures is crucial for program acceptance at the grassroots level.

The lack of cross-sector involvement is another key point. Program activities were mostly centered on health technical matters, without maximally involving social organizations, religious institutions, or community leaders. One informant from kelurahan stated that ideally, socialization should also be carried out through community channels. "Going forward, with cadres, OTAs, youth organizations, RTs, and others, we will also include how to provide understanding through religious groups. Through mosques, neighborhood gatherings, mosque caretakers, that Wolbachia is harmless" (R6, kelurahan). This approach was rarely used systematically in the program implementation, although it has great potential to reach the wider community.

Furthermore, the program's promotional strategy is considered still weak in facing challenges such as hoaxes and public resistance. Promotion was limited to the puskesmas environment and cadres, without broad and sustained media campaign support. "We are optimistic but need more promotion. Once hit by a hoax storm, it's difficult. There should be public service announcements on TV since this is a national program. It's a Ministry of Health program, so the Ministry of Health should broadcast it nationally" (R6, kelurahan). This statement emphasizes the importance of strengthening promotion not only locally but also nationally to build public awareness and legitimize the program.

External Factors

Besides social and structural challenges, the success of implementing the Wolbachia mosquito program in Bontang City is also influenced by various external technical and ecological factors. Two main aspects frequently mentioned by informants in the field are the environmental conditions of coastal areas and the inconsistent quality of supporting materials such as larval feed.

Some intervention areas are located in coastal regions, such as Bontang Kuala and Guntung, which have environmental characteristics of high heat, low humidity, and strong wind exposure. These conditions have proven to complicate the optimal hatching of Wolbachia mosquito eggs. One cadre shared their experience trying to hatch eggs in a coastal area: "In Bontang Kuala, the coastal area presented many technical challenges we encountered during egg hatching. I hatched the eggs at homes as a trial. I tried about 10–15 containers... Of the 15 containers I hatched, only 5 succeeded" (R2, cadre). This shows that not all areas have sufficient environmental carrying capacity to support the survival of Wolbachia-infected Aedes aegypti mosquitoes.

Similar observations were reported by health workers from the community health center (puskesmas), who noted a decrease in program effectiveness in coastal areas. "After the 6-month evaluation, Bontang Kuala and Guntung, being coastal areas with heat and wind, had poor mosquito results. So in North Bontang, only 4 sub-districts continued with SBH cadres until the end" (R11, puskesmas). This situation underscores the importance of entomological and environmental studies before intervention to ensure local climate and ecosystem conditions support the success of the applied technology. In addition, the findings confirm what previous studies in Yogyakarta and Buleleng suggested: that trust, communication continuity, and coordination are decisive for Wolbachia's acceptance. Theoretically, this highlights the role of risk communication models and participatory health promotion in sustaining community trust toward new biotechnologies.[20]

Besides environmental factors, another aspect affecting program success is the quality of larval feed used in the containers for egg hatching. Several cadres reported that feed quality was

not always consistent; some types caused egg hatching failure. “The larval feed quality is sometimes poor. Initially it was good, but not always the same. The second type of feed (reddish dog food) was not good, jelly-like and smelly. There was a layer on top. The eggs didn’t hatch. And it smelled very bad” (A4, cadre). Using inappropriate feed not only slows mosquito development cycles but also creates negative perceptions in the community when there are no visible results from the container installations.

A comparison of feed quality was further clarified by another informant: “The reddish feed almost never produced larvae; eggs didn’t hatch. But the flat brown feed was clean, with no red residue in the container. The brown feed is the good one” (R4, cadre). This shows that although containers and eggs were adequately available, lack of quality control on larval feed can be a weak link in the Wolbachia mosquito production chain.

In addition to these two main factors, other technical challenges also emerged, such as land-use changes at container placement points (e.g., vacant lots turning into buildings), difficulties accessing clean water, and long distribution distances. All of these indicate that the technical environment in the field has not been fully adjusted to the program’s needs. This mismatch results in reduced effectiveness at various points and complicates the work of cadres and caregivers (OTA) in carrying out their duties optimally.

Thus, it can be concluded that external factors such as the geographic conditions of coastal areas and the quality of technical supporting materials like larval feed are important determinants of the Wolbachia mosquito program’s success. Evaluation and adaptation based on local conditions are critical steps before scaling up the program, to ensure it is not only conceptually successful but also effective across the complex and diverse field conditions.

DISCUSSION

The findings show that initial community acceptance was relatively high, reflecting the importance of credible communicators such as cadres and health staff. This aligns with communication theory, which emphasizes the role of trusted messengers in influencing public perception. However, the sustainability of this acceptance was fragile. Limited socialization and the absence of ongoing risk communication made communities vulnerable to misinformation. Similar challenges have been observed in Wolbachia programs in Yogyakarta and Buleleng, where the lack of continuous communication weakened public support.[4]

However, the sustainability of this acceptance was fragile. Limited socialization and the absence of ongoing risk communication made communities vulnerable to misinformation. Similar challenges were found in Wolbachia programs in Yogyakarta, where effective cadre training enhanced community trust,[16] and in Buleleng, where weak leadership and low community participation hindered success.[9] These comparisons suggest that continuity of health communication is a decisive factor.

The spread of hoaxes via social media illustrates how rapidly misinformation can undermine public trust. Also emphasized the disruptive role of unverified content in health campaigns.[17] Without timely countermeasures, public trust eroded, even among initially supportive groups. This underlines the importance of structured and adaptive risk communication strategies in line with participatory models of health promotion.[7]

Cadres and OTAs played central roles, yet they faced heavy workloads, limited incentives, and inadequate technical support. This mirrors earlier findings that volunteer cadres often experience “role overload” when they manage multiple community health programs[8]. The mismatch between workload and recognition threatens sustainability unless addressed through fair incentives and training.

Institutional support also weakened over time, with irregular evaluations and poor data sharing. This is consistent with previous evaluations showing that weak inter-agency coordination undermines health innovations[18]. Limited involvement of local and religious leaders reduced legitimacy. As suggested embedding Wolbachia programs in ethical frameworks such as beneficence and community empowerment is vital to long-term acceptance.[20]

Ecological and technical barriers further complicated implementation. Coastal conditions reduced egg hatching success, while inconsistent larval feed quality highlighted gaps in material

quality control. Biological outcomes of Wolbachia interventions depend not only on mosquito release but also on environmental suitability.[5] Similarly, underlined that larval feed composition influences mosquito development cycles.[6]

The findings of this study are consistent with global evidence showing that the implementation of Wolbachia-infected Aedes aegypti can significantly reduce dengue transmission. Research conducted in Queensland, Australia, demonstrated the success of Wolbachia in lowering dengue incidence through phased mosquito release combined with intensive public communication strategies. Similarly, a study in Malaysia confirmed that the wAlbB strain was stably established in local Aedes aegypti populations and well-accepted by the community.[21]

The Indonesian context further reinforces this evidence. A quasi-experimental trial in Yogyakarta revealed that the deployment of Wolbachia mosquitoes significantly reduced dengue incidence using an interrupted time series analysis.[22] These findings were later validated by a large-scale clinical trial published in the New England Journal of Medicine, which confirmed the efficacy of Wolbachia as a sustainable dengue control strategy.[23]

However, biological effectiveness alone is insufficient without strong health communication strategies. A study from Southeast Asia emphasized that Wolbachia implementation requires social adaptation, strengthened community participation, and consistent risk communication to counter misinformation and public resistance.[24] Thus, the experience in Bontang highlights the necessity of reinforcing cross-sector communication and nationwide public campaigns, in line with the international evidence supporting Wolbachia programs.[25]

Overall, the study demonstrates that biological innovation alone is insufficient. Success depends on sustained communication,[4] strong institutional coordination,[18] motivated community actors,[8] and adaptation to local ecological contexts.[5] Addressing these factors is essential to ensure long-term community acceptance and program sustainability.

CONCLUSIONS

The Wolbachia mosquito program in Bontang City shows positive potential in preventing dengue fever, especially during the early stages of implementation. However, various challenges have emerged, such as public doubts due to ongoing dengue cases, misinformation that damages public trust, weak inter-agency coordination, and technical and environmental difficulties. Cadres face excessive workloads and irregular incentives, while caregivers (OTA) require more intensive guidance.

To strengthen the program moving forward, the following measures are needed: (1) continuous health communication, including a national campaign; (2) improved cadre management and fair incentive provision; (3) better cross-sector coordination and data integration; (4) adjustment of mosquito egg container placement locations based on environmental studies; and (5) standardization of technical materials such as larval feed and mosquito eggs. A collaborative and adaptive approach is essential for the program to be sustainable and accepted by the community.

Overall, Wolbachia shows promise as a sustainable dengue prevention strategy; however, its effectiveness depends on addressing barriers. Strengthening risk communication, launching broader public campaigns, improving cadre management and incentives, enhancing cross-sector collaboration, and standardizing technical materials (larval feed, egg quality) are critical for long-term sustainability.

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