Alternatives to Improve Mosquito Eradication Behavior: A Systematic Review

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Abstract
Background: Mosquito-Borne Diseases (MBDs) are still a health problem faced, especially in developing countries. Reducing the number of mosquitoes can be done by breaking the reproduction chain by getting rid of places that become nests. This systematic review aims to get an idea of what strategies or efforts can improve or change people’s behavior in eradicating mosquito nests.

Methods: This review was showed using the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) statement. Literature searches were conducted online on several databases such as Google Scholar, Science Direct, Cochrane Library, and Wiley Online Library. Sixteen studies met the criteria for this systematic review.

Results: Based on data extraction in the 16 pieces of literature reviewed, several strategies or efforts to improve community behavior towards mosquito nets eradication include Door-to-Door monitoring of house conditions, using control cards, empowering groups in the community (SHG), health education with the SGD approach, and promote the prevention of MBDs through social media.

Conclusion: All the strategies in this study are adequate for the community, but the pattern that should be done is to find out the root of the problem early (bottom-up). Communities need to be mediated to recognize their environment better, what they need related to health problems, especially MBDs.

Highlights:
What is current knowledge?
There are several strategies to improve community behavior in eradicating or controlling MBDs.

What is new here?
Effective strategies in controlling dengue vectors by the community are increasing community participation, decreasing house index, container index, and Breteau index, decreasing population exposure to dengue vector bites, decreasing Pupa index.

Introduction
Mosquito-Borne Diseases (MBDs) is an essential issue in the theme of public health because the situation is very complex. Several important factors, such as biological, ecological, and socioeconomic factors, greatly influence the incidence of MBDs in a particular area of the community or society (1-2). Various diseases are included in MBDs, such as malaria, dengue fever, typhoid, chikungunya, lymphatic filariasis, and Japanese encephalitis. These diseases have contributed significantly to the morbidity and mortality rates since they were first discovered. The prevalence of MBDs is common in areas with poor environmental sanitation conditions (3).

MBDs are a growing urban problem due to unplanned urbanization, industrialization, and overpopulation, coupled with rural to urban migration. In 2017, an estimated 219 million cases of malaria happened worldwide. Fifteen countries in sub-Saharan Africa and Southeast Asia account for 80% of global malaria incidence (1).

With the still high incidence of diseases caused by Mosquito-Borne Diseases (MBDs), it is necessary for the government and the public to make efforts to overcome both prevention and control, one of which is vector control. Vector control is the immediate action that can be taken on a community basis.

Community empowerment has been an essential pillar in the approach to principal health care since the 1970s. At the International Conference on Primary Health Care in 1978, the Alma Ata Declaration placed community participation at the center of effective primary health care delivery. It was also emphasized that the active participation of the community in planning and implementing programs could be in the form of contributing resources, money, or their own time, which is then expected to principal to a logic of ownership, responsibility, and ultimately more control over the determinants of their health (4). Community participation is vital for the prevention and control of the MBDs outbreak. Community participation is far below expectations because it depends on people's awareness and practice of the disease (5). The primary purpose of community empowerment is to mobilize the community to deal with health problems or other problems of concern to them. Community empowerment strategies can cause social cohesion, experience of community, and reinforce community assets, improving health consequences. The community empowerment approach has proven to be effective in promoting behavioral alteration in various health parts, including adolescent health growth (6), women’s health (7), and HIV/AIDS prevention (8).

Control of larval sources leftovers an effective mosquito control plan. Classifying and reducing inundation on a large scale is impractical, expensive, and unsuitable for sustainable vector control if the government does it alone (9, 10). Meanwhile, mosquito control by involving the community has proven successful in both the short and long term. Therefore, complementary efforts from centralized (government) and community initiatives are needed to increase effectiveness and sustainability as mosquito control methods (3, 11, 12). Several survey results explain the importance of the community's role in preventing and controlling the incidence of diseases caused by mosquitoes. The results of Sitti Chadijah's research (13) in Palu City, Central Sulawesi, Indonesia, found that community empowerment participation in dengue vector control was surveyor larvae (jumantik). Furthermore, Wiwik Trapsilowati's research (14) in Semarang City, Central Java Province, Indonesia, showed that the application of community empowerment methods in controlling dengue vectors (PMPV-DHF) in the intervention area obtained very good participation from DHF cadres, both in capacity building, involvement, volunteerism and scope of activities, with a score above 80% entomological evaluation in the intervention area with the indicator The larva free rate has a tendency to increase.

Therefore, it is crucial to comprehend interventions to intensify or transform community behavior in eradicating mosquito nests to reduce the incidence of Mosquito-Borne Diseases (MBD). The review aims to examine some relevant literature that focuses on improving the behavior of the community to eradicate mosquito nests in their respective living areas. This study provides an overview of several alternatives for policymakers in the success of national and international goals related to MBDs.
Methods
Design
This review was showed using the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA) statement. Through this study, various models or strategies are seen to improve community behavior in eradicating or preventing MBDs.

Identification of relevant studies
Relevant articles were searched and collected using databases such as ScienceDirect, Google Scholar, Cochrane Library, and Wiley Online Library, with a publication period between 2010 to 2021. Keywords were adjusted according to Mesh terms for health studies. The keywords used vary, depending on the search engine used. In general, the keywords focus on 'community participation' OR 'health promotion' OR 'community behavior' OR 'community engagement' OR 'citizen science' OR 'community empowerment' OR 'empowerment' AND 'mosquito borne disease' OR 'mosquito vectors' OR 'dengue OR Dengue Hemorrhagic Fever OR Malaria OR Aedes OR Anopheles OR 'disease vectors' AND surveillance OR 'communicable disease control' OR 'behavior control' OR 'mosquito control' OR prevention OR management.

Selection of studies according to the pre-established criteria
Inclusion criteria include intervention studies, programs, training, or educational strategies to support the improvement of community behavior in eliminating mosquito nests; analyze the effectiveness of the intervention by measuring changes in people's knowledge, attitudes, perceptions, or practices in eradicating mosquito nests; focuses on the community or groups in society. Our search strategy focuses on English and Indonesian language databases and publications. Articles were excluded or not reviewed if they only discussed the prevalence of MBDs incidence, analysis of risks associated with MBDs incidence (not referring to intervention strategies or health promotion), comment to editor, or systematic review.

Data Extraction and Analysis
Titles and abstracts are screened in each database. Complete text filtering was performed using Mendeley and extracted into Microsoft Word. The first author determined the selection of articles after a joint review of all authors' first sixteen full-text articles to establish explicit inclusion and exclusion criteria. The interpretations are presented in the table by taking the critical parts of the article.

Quality appraisal
Overall, articles were assessed using the NIH study quality assessment tool. A scoring sheet was advanced to measure the research methodology and devolution to the scoring criteria for each study that met the inclusion criteria of this study. Studies with scores <30% of the criteria are classified as "poor," scores between 30 and 70% are classified as "moderate," and scores >70% are classified as "good" study quality. The studies taken are studies that are classified as moderate and reasonable.

Results
The search returned 19,206 articles; after removing the duplicated articles, 11,638 articles were remaining, of which 11,615 articles were removed after screening titles and abstracts. The remaining 23 articles were reviewed and checked for eligibility, so seven articles were excluded. The final results were collected as many as 16 articles that encountered the inclusion criteria.

Characteristics of studies included
Sixteen articles were included in this review, four studies conducted in Indonesia, three studies in India, two studies in Cuba, and one each in Australia, Brazil, Bhutan, Burkina Faso, Malaysia, Philippines, and Thailand. The studies used a variety of designs, including quasi-experimental (n=12), RCT (n=3), and longitudinal (n=1). The sample size varied from 100 to 27,030, the study population with various ethnic backgrounds, including Asian, Hispanic, Australian, and African.

Analysis of community role enhancement model
This study identifies several strategies to improve community behavior in eradicating or controlling MBDs, including group management, where this model focuses on collaboration between researchers, Puskesmas, local government (Kelurahan/Village, sub-district), supervisors, city sanitation, Barangay (Kelurahan/subdistrict) officers, health cadres, community leaders, community organizations, private waste officers, health cadres. Another strategy is a direct action to the community, including Health education, educational campaign, and elimination of mosquito nests. The tactics identified in this review suggest that active education (e.g., door-to-door education) is more effective than passive education strategies like pamphlet distribution, television, and radio commercials. When carried out separately from other strategies, the passive education approach shows little or no influence on mosquito management outcomes. These findings are reinforced by the broader behavioral alteration literature, which has shown that knowledge gained as a strategy alone is often not sufficient to attain sustainable health outcomes.

In general, this review found that an effort to improve community behavior towards eradicating mosquito nests requires good cooperation between the local government, health services, community or community organizations, community leaders, or people who can represent in carrying out the planned program. The cross-sectoral collaboration shows effectiveness with the expected results. Several studies have shown that health workers responsible for community health, including people who represent the
community, are given training for some time in preparation to assist the community directly to increase awareness or change people's behavior about MBDS (39). In 2012, while another study in India only gave briefings to the Women Self-Help Group (SHG) related to monitoring activities of community houses, especially water reservoirs in each community's house (27). In addition, women's SHGs also show an active role in inviting the community to participate directly in cleaning their environment, especially the environment around their respective homes (22). SHGs are informal groups of people who come together to solve their problems together. Self-assist companies can serve many exclusive functions relying at the state of affairs and wishes (41). In the setting of ladies' empowerment, it's miles assessed, together with the results, in energy and pass toward similarly understanding and awareness. This process forms the basis for further empowering women. Self-assist organizations are a precious platform for enhancing women's health finished increasing knowledge and awareness about health issues and financial security during health emergencies (42). The composition of the SHG membership, families, and groups is the foundation in promoting health. Individuals, families, and groups are considered as participating in the health field when they are collectively accountable for their health, their families, and the environment, and are interested in establishing plans, implementing them, and solving problems in society (43). Water management interventions such as closing water reservoirs are included in the main activities to reduce the number of mosquitoes that cause disease (44). The study in the Philippines implemented an intervention to control water reservoirs by involving the city sanitation inspectorate, sub-district officers (Barangay), and health cadres. Instructions and guidance were given to the communities to observe mosquito larvae forms of mosquitoes in water containers and report difficulties encountered to health workers assigned to the area or local CHW. Although the desired results were not achieved, observations of the behavior change process provide an illustration of significance of information the social nature of urban communities, one of which is not responsive to the government's recommendation to participate in the provided training as evidence of the lack of community members joining the training program by researchers (45). It is in line with a study in Pakistan which stated that the inactivity or indifference of the community to government programs related to eradicating mosquito nests increased in epidemic conditions that occurred in a region. Good dengue control practices depend on public awareness campaigns and disseminating data approximately dengue; therefore, communities can eliminate dengue breeding locates if they contribute in dengue awareness campaigns and discuss dengue fever (46). One of the studies conducted an intervention in the form of giving a control card to each household. This control card contains a list of activities for cleaning the house and the environment; homeowners are encouraged to put a mark or checklist on the activity items listed on the control card. A designated field officer will visit each house at an unspecified time or not known by the community to check the control card given. If an activity is not checked on the control card, the officer will ask why not do it. At the end of the study, it was found that many households did not provide a checklist on their control card for reasons of forgetting or being lazy to fill it out (18). Both the government initiatives and the intervention research provided here are top-down, which may have contributed to resistance to intervention involvement. The community is, of course, involved in the research, but as participants rather than co-creators. It could explain the poor participation rate in the feasibility study, with just around one-fourth of participants using the control card as intended. There are three main reasons behind the community's refusal to participate, according to field officers: They believe that field officers, not themselves, are responsible for maintaining cleanliness (19). Previous research has suggested that bottom-up approaches are much more likely to be successful and sustainable (47). Therefore, it is imperative for the health authorities to know the community's opinion on the programmed DHF control program, in addition to continuously increasing the knowledge and motivation of the community to participate. The embodiment of a bottom-up strategy that can be applied and has proven effective in understanding public perception is the Small Group Discussion (SGD). Several studies conducted in Indonesia even found significant results compared to the lecture method (16). Group Discussions allow participants to express their complaints and opinions on a problem topic without feeling intimidated by the discussion group leader or other participants (48). Several obstacles in implementing Health Education in the community include lack of communication from health experts, and inadequate materials. The community is not interested in contributing in these educational activities, and they feel unable to control various things in life where they have to prioritize efforts in terms of their livelihoods (20). However, for dengue-related health education at the academic (student) level at universities, Health Education may increase students' awareness quite significantly. Health Education is provided through a social media platform, so it is highly recommended that the government use this method nationally, considering the number of social media users to date has increased very rapidly (21). In line with other studies in Malaysia, it is stated that good knowledge about Dengue positively improves people's attitudes and practices towards Dengue prevention (49). The type of knowledge needed by the community is also part of the morphological process of the disease, the signs and symptoms are shown by Dengue sufferers, to what actions must be taken to break the life chain of the Dengue vector, including family actions that must be taken if a family member suffers from Dengue or MBDS (50). The health campaign carried out by Australia as a developed country is very massive and structured under the name of the Fight the Bite program. It is insufficient to conduct MBDS campaigns on social media, television, radio, and even magazines/newspapers; for expansion of this national campaign program by advertising or calling on the public to work together with the government to make the Fight the Bite a program a success through posters distributed on strategic places such as bus terminals, airports, including the installation of billboards on the main streets of the city. In addition, this program also provides fight the Bite branding including stickers. After two years of intense implementation of this program, the together showed a significant increase in community awareness and prevention efforts independently (51). This systematic review was carried out to find effective strategies in supporting public awareness, ultimately in developing countries, concerning eradicating mosquito nests, better known as Vector control, where activities include cleaning places that can potentially become vector breeding locations. This study provides a clear view and evidence of the effectiveness of strategies implemented by the government and new strategies developed by academics. Limitation

The current review is limited on the literature search, where some databases are not used due to the limited resources to access some sources. However, the author's database in this study is considered representative of the entire existing study. This study in several studies does not thoroughly discuss the domain that is the variable. In addition, the selection of the language used is limited only to English-language studies.

Conclusion

The best strategy to improve or change people's behavior in eradicating mosquito nests or controlling MBDS is to recognize the root causes of problems in the community, especially the desires and obstacles in the community. Group Discussion can be an excellent choice to dig deeper into the community's perception and what steps are desired or best for themselves. Health Education, using control cards, door-to-door monitoring, empowering groups in the community, and promoting MBDS through social media is effective for the community, as long as it is under what is needed or following the community's ability.

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Ethical statement

The study was approved by the Health Research Ethics Committee of Komisi Etik Penelitian Kesehatan Poltekkes Kemenkes Jambi (Reference number LB.02.06/2/190/2021).

Conflict of interest

The authors declare that there is no conflict of interest.

Author contributions

ECH and AJ were responsible for the study conception and design; AJ, SY, SF performed the data collection; and AJ and SY performed the data analysis; ECH, and SF were responsible for the drafting of the manuscript; ECH and SF made critical revisions to the paper for important intellectual content.

References

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<tr>
<th>Author, Date, Title</th>
<th>Location</th>
<th>Study Type</th>
<th>Study Aim</th>
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<tr>
<td>Abhey Potter, Andrew Jardine, Annette Morrissey, Michael D. A. Lindsay, (2019). Evaluation of a Health Communication Campaign to Improve Mosquito Awareness and Prevention Practices in Western Australia (26)</td>
<td>Australia</td>
<td>Case-Control Study</td>
<td>This study presents the findings of an evaluation survey conducted after a two-year trial period to assess the campaign model's efficiency and efficacy, as well as the influence it had on public awareness and mosquito prevention practices in WA.</td>
<td>Regional newspapers, geo-targeted Facebook advertising, a billboard, railway station shoplifters, tourist maps, radio, television, outdoor cinema advertising, and a presence in the international airport departure lounge were all used to promote the campaign.</td>
<td>The computer assisted telephone interview (CATI) survey</td>
<td>The computer assisted telephone interview (CATI) survey</td>
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<td>Tashi Tobgay, Deki Pem, Urgen Khunga, Shewon P. Dumer, Kesara Na-Bangchang, Cristina E Torres, (2003). Community-directed educational intervention for malaria elimination in Bhutan: quasi-experimental study in malaria endemic areas of Surpang district (27)</td>
<td>Bhutan</td>
<td>quasi-experimental study</td>
<td>To determine the efficacy of community-directed malaria preventive and control initiative in malaria-endemic areas of Bhutan’s Surpang district.</td>
<td>The community-directed educational intervention (CDEI) involved training health staff and local leaders who in turn trained community action groups (CAGs) that were nominated by the communities. Before the intervention, 13 in-depth interviews and 12 focus group discussions were conducted, and nine in-depth interviews and four focus group discussions were conducted following the intervention.</td>
<td>The computer assisted telephone interview (CATI) survey</td>
<td>The overall knowledge regarding mosquito &amp; mosquito control measures was significantly improved after intervention (p &lt; 0.001). The study resulted in a significant improvement during post-intervention in knowledge, attitude and practice (p &lt; 0.001).</td>
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<td>Prajapati Arpith, Parikh Somal, Fancy Manish, Bala D. (2012). Impact of community-directed educational intervention Regarding mosquito borne diseases and their Control measures among the link workers of Urban health centers (UHCS) of Ahmedabad City (25)</td>
<td>India</td>
<td>Pre-Post Intervention study</td>
<td>To assess the link workers’ knowledge of mosquito-borne diseases and control strategies. 14 days following a single educational session, provide training and assess knowledge improvement.</td>
<td>The pre-intervention questionnaire was used to assess link workers’ knowledge of mosquito-borne diseases and control strategies. Single educational intervention training for 45 minutes in 14 days.</td>
<td>Questionnaires were used to examine participants before and after training.</td>
<td>Both groups had their questionnaire evaluations measured three times.</td>
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<td>Sudha Hankaik, Paul Rataniatpong, Sukgeorn Sivavut (2018). Effectiveness of the intervention program for dengue hemorrhagic fever prevention among rural communities in Thailand: A quasi-experimental study (21)</td>
<td>Thailand</td>
<td>Quasi Experimental study, Case- Control approach</td>
<td>The goal of this study was to test how effective the intervention program for preventing dengue hemorrhagic fever was in rural communities.</td>
<td>The intervention group got a five-week dengue hemorrhagic fever preventive program that included information broadcast, a campaign in a model house contest, and group instruction. The control group only received the standard of treatment provided by health-promoting hospitals.</td>
<td>Both groups had their questionnaire evaluations measured three times.</td>
<td>There were significant differences in knowledge, perceived susceptibility, perceived severity, perceived benefit, perceived barriers , preventive action and HI in the intervention group after the five-week intervention program and at three-month follow-up (p &lt; 0.05).</td>
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<td>Tri Wahyuni Sukes, Tri B. T. Satoto, Elia H. Murbandarwati, Retna Sivi Padmadwini, (2021). Effects of Health Education Based Intervention on Community’s Perception, Healthy House, and Social Capital of Dengue in Endemic Area of Semarang Regency Indonesia (29)</td>
<td>Indonesia</td>
<td>Quasi experiment - Participatory action research approach</td>
<td>To determine the impact of DHI health education on community views, social capital, and healthy housing circumstances.</td>
<td>The intervention group got a Health education about DHI: Using Questionnaire after 6 months intervention.</td>
<td>The results show that in the 6 months after the intervention, there was an increase in the average score of all variables. The differences between pre- and post-intervention were statistically significant: Perceptions of dengue fever (p = 0.001); perceptions about DHI control (p = 0.000); the social condition for the component of concern, trust, and readiness to learn new ideas with p &lt; 0.05; and all component of healthy house conditions with p &lt; 0.05.</td>
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<td>Natarajan Arumachalam, Brij Kishore Tyagi, Miriam Samuel, R. Krishnamoorthy, R. Manavalan, Satish Chandra Tevari, V. Ashokkumar, Axel Kroeger, Johannes Sommerfeld, Max Petzold, (2012). Community-based control of Aedes aegypti by adoption of eco-health methods in Chennai City- India (17)</td>
<td>India</td>
<td>A cluster randomized controlled trial</td>
<td>To determine the efficacy of a community-based environmental intervention package for controlling the dengue vector Aedes aegypti, as well as the favorable and limiting factors.</td>
<td>Women’s Self-Help Groups (SHGs) in the community assisted with the distribution of water container covers and health education materials, as well as assisting the researchers in the organization of meetings by giving tea and refreshments to those who attended. During clean-up activities, the ladies were also actively involved and took responsibility for cleaning the surroundings. When complaints about insufficient solid waste pickup arose early in the trial, the researchers assisted the community on three occasions in obtaining services.</td>
<td>Household survey on people’s knowledge, attitude, and practices using Questionnaire Focus group discussions (FGDs) with health-care providers and community members. Key informant interviews with health-care providers and community leaders. Community-based approach that promoted interventions to prevent breeding of dengue vectors, and was targeted at multiple stake-holders within communities, led to substantial reduction in the density of dengue vectors. Participation of community members was ensured, addressing the fundamental need for people to be involved.</td>
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<td>Andrea Caprara, Jose Wielopolski, Decio Lima, Ana Carolina Rocha Peixoto, Cyntia Monteiro Vasconcelos Mota, Joana Mary Soares Nobre, Johannes Sommerfeld, and Axel Kroeger, (2015).</td>
<td>Brazil</td>
<td>Cluster randomized controlled trial</td>
<td>Implement a novel intervention method in Brazil based on an eco-health approach and assess its effectiveness and costs in reducing Aedes aegypti vector density, as well as its Workshops for the community; community participation in clean-up campaigns; covering elevated containers and in-house waste disposal without larviciding; mobilization of schoolchildren and senior citizens, and distribution of</td>
<td>Using Questionnaire and interviews.</td>
<td>The study results showed the effectiveness of the eco-health program in terms of a significant reduction of the dengue vector population through targeted interventions in the most productive container types. The project also achieved an increase in people’s...</td>
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## Alternatives to Improve Mosquito Eradication

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<tr>
<th>Study Title</th>
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- Researchers intended to explore how effective a community empowerment method combined with a routine disease vector control.
- Control cards focused on critical household duties for dengue control were chosen as an intervention to raise awareness and assist individual families' dengue prevention efforts.
- The usage of control cards resulted in a low level of community participation. In several socioeconomic groups, despite continuing programs aimed at engaging the community in dengue prevention, knowledge levels were low and adherence to target groups was poor. Bottom-up solutions involving all community members in dengue control, not just those who currently follow excellent practices, are essential to boost motivation levels.
Evaluating Effect of Social Support Programs …

community empowerment strategy embedded in a routine dengue vector control programme: a cluster randomized controlled trial (40)

program could be in La Lisa, Havana City, Cuba.

Aedes aegypti foci are detected. Health Education and Enforcing Mosquito Control Legislation through Fines, a participatory strategy rooted in empowerment and popular education framework's dimensions: needs assessment, leadership, organization, resource mobilization, and management.


Cuba Longitudinal study To evaluate the achievements of a six-year project including inter-sectoral collaboration and community empowerment in Playa Municipality, Cuba.

Two major stages of the intervention are separated by two dengue outbreaks. The first step aimed to improve cross-sectoral coordination. A parallel strategy focusing on community empowerment was launched in August 2003 in half of the intervention area. Routine dengue control activities proceeded in the control region without any additional input.

Entomologic surveillance, Breteau Index (BI) per health area

Before beginning the intervention, the BI in the control area had the lowest value. This was reversed one year after inter-sectoral dengue control activities were launched in the intervention region. Despite spraying in all locations, until December 2002, there were significant differences in BI between intervention and control areas. Although no variations were seen over the next two years, they became substantial again in December 2004, which coincided with the deployment of a community-based vector control approach in the intervention region.

How to Cite: