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Malaria Vector Surveillance Training to Improve Community Health Cadre Knowledge and Skills in a Malaria-Endemic Area

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ABSTRACT
Background: *Malaria remains a significant public health challenge in Purworejo Regency, Central Java Province, Indonesia, with persistent transmission despite various preventive measures This community services aimed to improve community health center (puskesmas) cadres' knowledge of malaria transmission and their practical skills in identifying breeding sites, vector surveillance, and environmental management.*

Methods: *This community engagement initiative aimed to enhance the knowledge and skills of community health center (puskesmas) cadres in identifying malaria vectors and conducting mosquito habitat surveys. The project involved 28 cadres from puskesmas across Purworejo Regency and was conducted in Banyuasin Village, Loano Subdistrict. The intervention consisted of educational sessions on malaria basics and mosquito identification, followed by hands-on training in field-based habitat survey techniques. Pre- and post-tests were administered to assess the effectiveness of the training.*

Results: *Descriptive analysis revealed a significant improvement in participants' knowledge following the intervention. The mean score increased from 22.1 before the training to 28.8 after the training, with the difference being statistically significant ($p < 0.05$, paired samples t-test).*

Conclusion: *The findings suggest that community-based education and capacity-building initiatives, involving the direct participation of community members and health cadres, can effectively improve awareness and knowledge related to malaria control. The findings suggest that community-based education and capacity-building involving community members and health cadres can improve malaria awareness and knowledge, and sustained implementation with collaboration among local government, public health institutions, and the community is essential for understanding malaria risks, promoting preventive practices, and ensuring sustainable control efforts.*

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community health center staff; community participation; malaria; malaria vector; training

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INTRODUCTION

Malaria remains a serious challenge in public health in Indonesia due to *Plasmodium* species transmitted by *Anopheles* mosquitoes (1). The persistence of malaria transmission is driven by a combination of environmental conditions and human behavioral factors that facilitate contact between vectors and hosts (2). The environment plays a major role in the spread of malaria, as mosquitoes breed rapidly under favorable conditions (3). The environmental characteristics such as the presence of standing water, breeding sites, animal pens near settlements, and chemical influences on the environment, including pH and salinity, further contribute to the spread of malaria (4).

Biological factors also influence transmission, including 80 species have been identified in Indonesia; however, only 31 species act as malaria vectors (5). Socio-cultural environmental factors are also closely linked to the habits of communities near malaria-endemic areas, such as the custom of being outdoors at night—a time when rapid malaria transmission is most likely (2). Other factors, such as climate—including temperature, humidity, and rainfall within certain ranges—support the proliferation of *Anopheles* mosquitoes and influence the development of *Plasmodium* within the mosquito vector (6). After transmission through the bite of an infected *Anopheles* mosquito, *Plasmodium* parasites initially infect hepatocytes in the liver and subsequently invade red blood cells, where they multiply and cause clinical symptoms of malaria (7).

Generally, malaria is found in tropical and subtropical regions between 60° north and 40° south latitude (8). Indonesia is an archipelago with a heterogeneous climate that is susceptible to regional and global climate change, which affects environmental conditions that contribute to the spread of malaria (9). According to the 2021 malaria case summary in Indonesia, a total of 304.607 cases were recorded, with Purworejo Regency as one of the malaria-endemic areas (10). Historically a major hotspot, Purworejo Regency reported 558 cases in 2021 with a Case Fatality Rate (CFR) of 1.1%. In 2022, there were 561 cases with a significantly lower CFR of 0.2% (11,12). Following this, the number of cases fell precipitously to 49 in 2023 and 12 in 2024; no deaths were reported during these years (13,14).

Untreated malaria efforts, such as gaps in community knowledge, health-seeking behavior, and access to appropriate care, remains a critical challenge in endemic settings (15). Thus, community health cadres were selected as the primary target of this program due to their strategic role as frontline agents in health promotion at the community level. Strengthening their capacity is expected to enhance early detection, timely referral, and community awareness of malaria prevention. This approach also supports the sustainability of malaria control efforts through improved community engagement and participation (16).

However, there is a lack of hands-on training designed specifically for community health cadres, particularly in identifying and monitoring mosquito breeding sites. This limitation reduces their effectiveness as proactive actors in community-based malaria prevention. Therefore, this activity aims to strengthen cadres' understanding of malaria transmission, enhance their ability to identify potential mosquito breeding sites, and improve their practical skills in vector surveillance and environmental management (16). This gap highlights the urgent need for structured community-based training interventions to improve cadres' competencies. Strengthening these capacities is essential to support more effective and sustainable malaria control efforts at the community level.

Furthermore, the initiative encourages cadres to increase community awareness and foster community participation in reducing mosquito breeding habitats. This program emphasizes a participatory approach by involving cadres through the provision of educational materials and direct training in the field. This approach involves the integration of guided field practice and observational activities to identify mosquito breeding sites and to discuss appropriate environmental control measures.

METHODS

The partners in this community service initiative were the Loano Community Health Centre and the Loano Sub-district Government, Purworejo Regency, which acted as facilitators and liaisons with community health workers in the area. The primary target of this initiative was community health workers in malaria-endemic areas, particularly in Banyuasin Village, Loano Sub-district. The activity was carried out through collaboration between the community service team from the Faculty of Public Health at Diponegoro University and the local health centre and sub-district government. The activity was implemented in a participatory manner, involving community health workers as active partners throughout the entire process, from preparation and training to evaluation.

Activity Preparation

The community service activities were carried out by identifying and collecting references related to malaria cases in Loano Subdistrict, Purworejo Regency. The educational materials to be delivered were organized in an interactive format. In addition to the materials, preparations were made for the tools and materials used for field practice to ensure the smooth implementation of the community service activities.

Furthermore, the objectives of the community service activities were explained to the Head of Loano Subdistrict, an agreement on the activity schedule was reached between FKM Undip and Loano Subdistrict, and the number of participants involved was determined. This activity applied a community-based educational intervention using a participatory training approach involving health cadres.

Pretest Phase

The activity was conducted on April 22, 2025. This community service activity took place at the Loano Subdistrict Village Hall. The event was held in Banyuasin Village, Loano Subdistrict, Purworejo Regency, which is one of the malaria-endemic areas. The activity began with *a pretest* to assess the health cadres' initial understanding of malaria and its vectors. The primary target of this activity was the health cadres, who serve as the frontline in disseminating information and controlling vectors within the community.

Educational Intervention

The activity was conducted through the delivery of educational materials in the form of active and interactive discussions led by faculty members and students from the Faculty of Public Health at Diponegoro University. The training modules covered basic concepts of malaria, mosquito identification, and malaria vector ecology. The educational sessions were followed by practical field activities in which participants were guided to observe and identify potential mosquito breeding habitats as part of habitat survey practices. Following the presentation of the materials, the health center cadres were guided to participate in field training regarding the steps for conducting mosquito habitat surveys.

The community health center cadres were actively involved throughout the community service process. Such community-based participatory engagement methods have proven effective in various previous community service studies (17). The training of cadres, conducted as part of a community empowerment strategy in several studies, has proven effective for controlling infectious diseases, including malaria (17). Additionally, the practice of conducting larval habitat surveys and identifying mosquitoes is relevant and crucial for developing strategies within the malaria vector surveillance system (18). The training activity was conducted in a one-day session consisting of educational lectures followed by field practice activities.

Posttest Phase

Following the delivery of educational materials and field practice, a posttest was administered using the same questions as the pretest. The objective was to ensure that the presentation of materials and field practice resulted in increased knowledge among health center cadres. The results were then compared with the pretest scores to evaluate the effectiveness of the intervention.

Data Analysis

Data on scores from the pretest and posttest were analyzed using the paired t-test to determine the percentage increase and the significance level of the education provided to community health center cadres. The paired t-test is effective for determining the impact of the educational intervention after the pretest and comparing it with the results after the posttest. A p-value of < 0.05 was considered statistically significant in assessing the effectiveness of the intervention.

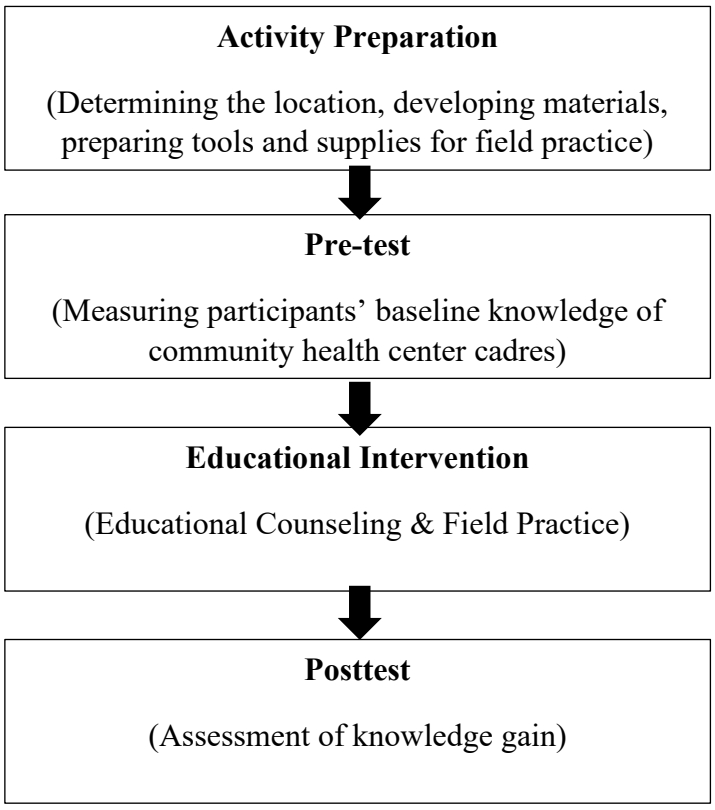

Figure 1. Stages of Community Service Activities

RESULTS

This community service activity for community health center cadres in Banyuasin Village, Loano Subdistrict, Purworejo Regency aimed to provide understanding regarding malaria through the community health center cadres. The cadres received both classroom instruction and field-based practice on human vector surveillance techniques (Figure 1) to assess participants' knowledge before and after intervention, the pre-test and post-test were conducted in a structured setting as shown in Figure 2.

The results of the *pre-test* showed an average score of 22.1. Following the educational intervention and field practice, the average *post-test* score increased to 28.8 (Table 4). Participants actively engaged in identifying mosquito breeding sites and conducting environmental observations. The participating community health center cadres showed high enthusiasm in taking part in the outreach activity.



Figure 1. Implementation of human vector surveillance training in Banyuasin Village, Loano Subdistrict, Purworejo Regency. The figure shows (A) the delivery of training materials on *Anopheles* mosquito species and their morphological identification to community health cadres, and (B) field practice where cadres conducted larval habitat inspection guided by facilitators.



Figure 2. Administration of the pre-test and post-test during the community education session with community health center cadres in Banyuasin Village, Loano Subdistrict, Purworejo Regency.

Table 1. Pretest Results of Participants' Knowledge on Malaria and Mosquito Identification

No.	Statement	Frequency	
		Correct (%)	Incorrect (%)
1	Female *Anopheles* mosquitoes are the type of mosquito that transmits malaria.	100	0
2	Of the approximately 200 Plasmodium species, 10 species have been confirmed to transmit malaria to humans.	7	93
3	*Plasmodium* infects the human kidneys.	57	43
4	Merozoites are the infectious form capable of infecting human red blood cells/the host of malaria.	96	4
5	The trophozoite transforms into a schizont, which then ruptures and releases merozoites.	89	11
6	The invasion or infection process of *Plasmodium* into red blood cells is not related to the clinical symptoms of malaria (fever).	75	25
7	Sexual reproduction occurs in mosquitoes.	75	25
8	Sporozoites migrate to the lymph nodes to infect humans.	36	64
9	*Anopheles* mosquitoes are vectors of malaria.	93	7
10	*An. kochi* is one of the species of malaria vectors.	82	18
11	*Aedes aegypti* can transmit malaria.	96	4
12	*Culex* is not a malaria vector.	54	46
13	One method of malaria vector control is distributing mosquito nets to residents.	96	4
14	Feeding goats or cattle in the late afternoon or evening can lead to malaria transmission.	93	7
15	Malaria-carrying mosquitoes usually bite us during the day.	96	4
16	Breeding sites for malaria-carrying mosquitoes can be found in water holes used by buffalo, cattle, and ducks.	93	7
17	We need to monitor people returning from Papua and check their malaria status to	100	0

No.	Statement	Frequency	
		Correct (%)	Incorrect (%)
	determine whether they are currently infected or not.		
18	Rice fields are not a preferred habitat for malaria vectors.	71	29
19	Malaria-carrying mosquitoes can live in septic tanks.	82	18
20	*Anopheles* mosquito larvae do not have respiratory siphons.	61	39
21	Female mosquitoes have denser antennae than male mosquitoes.	25	75
22	*Anopheles*, *Aedes*, and *Culex* mosquitoes have the same resting position as adults.	82	18
23	*Anopheles* mosquitoes have a rounded, single-lobed scutellum.	54	46
24	The maxillary palps of female *Anopheles* mosquitoes are the same length as the proboscis.	64	36
25	The morphology of a mosquito consists of three main segments: head, thorax, and abdomen.	79	21
26	Swamps are common breeding grounds for *Culex* and *Anopheles* mosquitoes.	100	0
27	The mosquito's proboscis does not function as a feeding or sucking organ.	64	36
28	One of the favorite breeding sites for *Anopheles* mosquitoes is puddles of water on the hooves of animals.	89	11
29	*Anopheles* mosquitoes cannot survive in flowing water or estuaries.	43	57
30	Puddles of water from gold panning sites can serve as habitats for *Anopheles* mosquitoes.	61	39

Table 1 shows the results of the participants' pre-test knowledge regarding malaria and mosquito identification in Banyuasin Village, Loano Sub-district, Purworejo District. In general, the rate of correct answers varied across each statement, with some items indicating a very high level of understanding, such as the role of Anopheles mosquitoes as malaria vectors. However, conceptual errors were still found in several key aspects, such as the life cycle of Plasmodium, the morphological characteristics of mosquitoes,

and the habitats of malaria vectors. Several items also indicated a low level of understanding among participants, for example, regarding the number of Plasmodium species that infect humans and the characteristics of the antennae of male and female mosquitoes. These results highlight a gap in prior knowledge, underscoring the need for further educational interventions and training for health cadres.

Table 2. Posttest Results of Participants' Knowledge on Malaria and Mosquito Identification

No.	Statement	Frequency	
		Correct (%)	Incorrect (%)
1	Female *Anopheles* mosquitoes are the type of mosquito that transmits malaria.	100	0
2	Of the approximately 200 *Plasmodium* species, 10 species have been confirmed to transmit malaria to humans.	96	4
3	*Plasmodium* infects the human kidneys.	86	14
4	Merozoites are the infectious form capable of infecting human red blood cells/the host of malaria.	100	0
5	The trophozoite transforms into a schizont, which then ruptures and releases merozoites.	96	4
6	The invasion or infection process of *Plasmodium* into red blood cells is not related to the clinical symptoms of malaria (fever).	64	36
7	Sexual reproduction occurs in mosquitoes.	100	0
8	Sporozoites migrate to the lymph nodes to infect humans.	86	14
9	*Anopheles* mosquitoes are vectors of malaria.	100	0
10	*An. kochi* is one of the species of malaria vectors.	100	0
11	*Aedes aegypti* can transmit malaria.	100	0
12	*Culex* is not a malaria vector.	89	11
13	One method of malaria vector control is distributing mosquito nets to residents.	100	0
14	Feeding goats or cattle in the late afternoon or evening can lead to malaria transmission.	100	0
15	Malaria-carrying mosquitoes usually bite us during the day.	100	0
16	Breeding sites for malaria-carrying mosquitoes can be found in water holes used by buffalo, cattle, and ducks.	100	0

No.	Statement	Frequency	
		Correct (%)	Incorrect (%)
17	We need to monitor people returning from Papua and check their malaria status to determine whether they are currently infected or not.	100	0
18	Rice fields are not a preferred habitat for malaria vectors.	93	7
19	Malaria-carrying mosquitoes can live in septic tanks.	93	7
20	*Anopheles* mosquito larvae do not have respiratory siphons.	96	4
21	Female mosquitoes have denser antennae than male mosquitoes.	100	0
22	*Anopheles*, *Aedes*, and *Culex* mosquitoes have the same resting position as adults.	100	0
23	*Anopheles* mosquitoes have a rounded, single-lobed scutellum.	100	0
24	The maxillary palps of female *Anopheles* mosquitoes are the same length as the proboscis.	93	7
25	The morphology of a mosquito consists of three main segments: head, thorax, and abdomen.	100	0
26	Swamps are common breeding grounds for *Culex* and *Anopheles* mosquitoes.	100	0
27	The mosquito's proboscis does not function as a feeding or sucking organ.	100	0
28	One of the favorite breeding sites for *Anopheles* mosquitoes is puddles of water in animal footprints.	100	0
29	*Anopheles* mosquitoes cannot survive in flowing water or estuaries.	93	7
30	Puddles of water from gold panning sites can serve as habitats for *Anopheles* mosquitoes.	100	0

Table 2 shows the results of the post-test assessing participants' knowledge following an educational intervention on malaria and mosquito identification in Banyuasin Village, Loano Sub-district, Purworejo District. Overall, there was an increase in the percentage of correct answers for almost all items compared to the pre-test results. Most statements indicated a very high level of understanding, with many items achieving 100% correct answers, particularly regarding malaria vectors and control measures. Nevertheless, there were still some items with relatively higher error rates, particularly

concerning the biological concepts of Plasmodium and the infection process. Overall, these results indicate that the educational intervention and training provided were effective in improving participants' knowledge.

Table 3. Results of Pretest–Posttest Comparison and Paired Sample T-Test Analysis of Community Health Cadres' Knowledge Improvement (n=28)

Analysis Component	Pre-test	Post-test	Mean Difference	Std. Deviation	SE Mean	t	df	p-value
Knowledge Score	22.1	28.8	-6.67	2.49	0.47	-14.1	27	<0.001
Correlation (Pre–Post)						-0.20		0.91

The table shows the results of a comparative analysis of pre-test and post-test scores among health cadres in Loano Sub-district, Purworejo Regency, following their participation in malaria vector surveillance training. The average knowledge score increased from 22.1 in the pre-test to 28.8 in the post-test, with a mean difference of -6.67. The results of the Paired Sample T-Test indicated a statistically significant difference (p = <0.001), signifying an increase in knowledge following the intervention. The correlation coefficient between the pre-test and post-test was -0.20 with a significance level of 0.91, indicating the absence of a strong linear relationship between the two measurements. Overall, these results suggest that the training provided was effective in improving health cadres' knowledge regarding malaria vector surveillance.

DISCUSSION

The results of the pre-test conducted during the community service activity involving health center cadres in Loano Subdistrict, Purworejo Regency, Purworejo Regency indicated that the participants had a relatively limited initial understanding of malaria vector surveillance. After the educational intervention, the post-test results showed an improvement in participants' knowledge, indicating that the training activities effectively enhanced the cadres' understanding of malaria transmission and vector control.

This study has also shown that health education interventions contribute substantially to improving knowledge and preventive practices related to malaria control among community members (19). Recent evidence from malaria control initiatives indicates that participatory educational methods, such as demonstrations and experiential learning in the field, significantly enhance the community's understanding of vector surveillance activities (20). This finding is consistent with the present activity, where the combination of educational sessions and field-based practice helped cadres better understand mosquito breeding habitats and vector surveillance activities.

There were 28 participants in the training, consisting of community health center cadres in Purworejo Regency. The increase in knowledge was observed after participants received information from the relevant experts. This finding highlights the importance of strengthening the capacity of community health cadres given their pivotal role in disseminating health information and facilitating vector control initiatives at the community level. Community empowerment through direct community participation and the involvement of health cadres has been proven to influence positive change (17). A

study on a similar malaria-related case conducted by (21). This study noted that knowledge levels influence the spread and reduction of malaria case surges.

These findings support the results of the present activity, suggesting that improving knowledge among health cadres can contribute to strengthening community-based malaria prevention efforts. Frequent public awareness campaigns and health education sessions on malaria conducted by community health centers, health departments, and universities/students have been shown to significantly influence the increase in public awareness, thereby reducing malaria cases in the areas where these campaigns are implemented.

However, in the implementation of this community service activity, several obstacles were encountered in the field. One of the main challenges was the limited duration of the training, which took place over just one day, meaning that participants did not have sufficient opportunity to explore the entire syllabus in depth. Furthermore, variations in the cadres' educational backgrounds and experience led to differences in the speed at which they grasped the material presented. The lack of facilities to support field practice also poses a challenge to the optimisation of direct vector surveillance activities.

Given these constraints, improvements are needed in terms of planning the duration and methods of training for future activities. It is recommended that similar activities be conducted over several sessions so that the learning process can take place in a more gradual and in-depth manner. Furthermore, teaching methods need to be enhanced with a more interactive approach based on real-life field cases. The provision of additional learning materials, such as printed modules and educational videos, is also recommended to support participants' independent learning.

Another recommendation is the need to strengthen collaboration between educational institutions, community health centres, and local governments to support the sustainability of the programme. Health cadres need to receive continuous training to ensure that their competence in malaria vector surveillance is maintained and improved. Regular evaluations are also important to assess the effectiveness of implementing the knowledge gained within the community. In this way, community-based malaria control efforts can be more effective, sustainable, and have a long-term impact.

CONCLUSIONS AND SUGGESTIONS

The implementation of the Human Vector Surveillance Training in Banyuasin Village, Loano Subdistrict, Purworejo Regency demonstrated an improvement in cadres' knowledge of malaria vector surveillance as evidenced by an increase in mean scores. These findings indicate that participatory training combining educational sessions and field practice is effective in strengthening cadres' capacity in identifying mosquito breeding sites and understanding malaria transmission. Follow-up activities, such as outreach sessions and hands-on field practice, should be conducted periodically to maintain and improve cadres' competencies in malaria vector surveillance. In addition, this training program should be integrated into routine puskesmas activities to ensure sustainability. Regular monitoring and evaluation, such as follow-up assessments or field supervision, are also recommended to assess the application of the acquired skills. Strengthening collaboration between puskesmas, local health offices, and academic institutions is also recommended to support sustainable community-based malaria control efforts.

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DECLARATION OF USE OF AI IN SCIENTIFIC WRITING

AI tools were used solely for grammar and language editing. The authors take full responsibility for the content and integrity of the manuscript.

CONFLICT OF INTERESTS

There were no conflicts of interest related to the community service activity.

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