RESEARCH ARTICLE

Vector detection using ovitrap: A study of dengue vector patterns in Marang, Terengganu

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Abstract:

Despite all efforts to eradicate dengue fever in Malaysia, dengue fever cases are still increasing, both in populated and lower population density areas. In Kampung Rusila and Taman Sena Rendang in Marang District especially, cases of dengue fever have shown a marked increase for the last several years despite these areas having very different population densities. As part of the effort to eradicate dengue, this study aims to visualize the patterns of dengue vectors in these two localities. A total of 780 ovitrap were installed in these two localities between June and December 2020. Statistical analysis showed that there is no significant difference between the POI and MET for both localities (*p-value* > 0.05) even though Taman Sena Rendang has a much smaller population than Kampung Rusila. Overall, ovitrap is a reliable tool for vector control and surveillance to attract and capture *Aedes* mosquito species.

Keywords: MET, Ovitrap, Pattern of dengue vector, Point of Interest (POI)

1. INTRODUCTION

Dengue is a mosquito virus that can survive in warm tropical climates, and there are four (4) types of viruses that can be found in Malaysia: denv 1, 2, 3, and 4. All four types interact differently with antibodies in human blood serum, which is also known as serotypes (Gubler, 2008). When infected, patients will experience various symptoms, including mild, moderate, and severe. Severe symptoms can result in death, and as of now, there are no particular treatment that can cure the disease (Guy et al., 2015; WHO, 2021). Despite technological and medical advances, WHO is still listing dengue fever as a major public health problem (Seidahmed et al., 2018), and current issue of climate change ies expected to cause even more problems, as change of seasons and unstable weather pattenrs will affect dengue outbreaks. Other factors that affect breeding patterns and mosquito populations include high mosquito populations, susceptibility to poisons, ambient temperature, rainfall distribution, and good humidity (Polwiang, 2015). According to the State Health Director of the Terengganu Health Department, from January to April 2018, 107 cases of dengue were recorded. Despite the large number of cases, this is a marked decrease of 59.5% or 157 cases compared to 264 cases in the same period last year (Bakar, 2020).

At present, the Malaysian Ministry of Health is implementing various techniques in dengue control program to combat the increasing number of infections. Chemical, physical, and biological controls are among the mechanisms used. In addition to generally managed measures, the development of vaccines has provided effective disease prevention and management (Rather et al., 2017). Vector surveillance with ovitraps is more effective for dengue surveillance due to its lower cost than existing dengue control surveillance programs. With ovitrap surveillance, information on dengue outbreaks can be predicted. Ovitrap activities were performed to study the abundance and distribution of *Ae. aegypti* and *Ae. albopictus* populations in dengue-endemic areas (Noor Afizah et al., 2018). Therefore, as part of the effort to combat the prevalence of dengue, this study will utilize ovitraps to visualize the patterns of dengue vectors in Taman Sena Rendang and Kampung Gong Rusila in Marang, Terengganu.

2. MATERIALS AND METHODS

2.1. Study Site

This study was conducted in Marang District (5.160835°N, 103.182076°E), Terengganu, which shares a border with Kuala Terengganu district. As of current data, 111,200 residents live in the area, consisting of Malays, Chinese, Indians, and others. Within this district, two locations were selected, Taman Sena Rendang and Kampung Rusila. The selection of these two sites is due to the high occurrence of dengue cases in both areas contributes significantly to the increase in dengue cases in the Marang district.

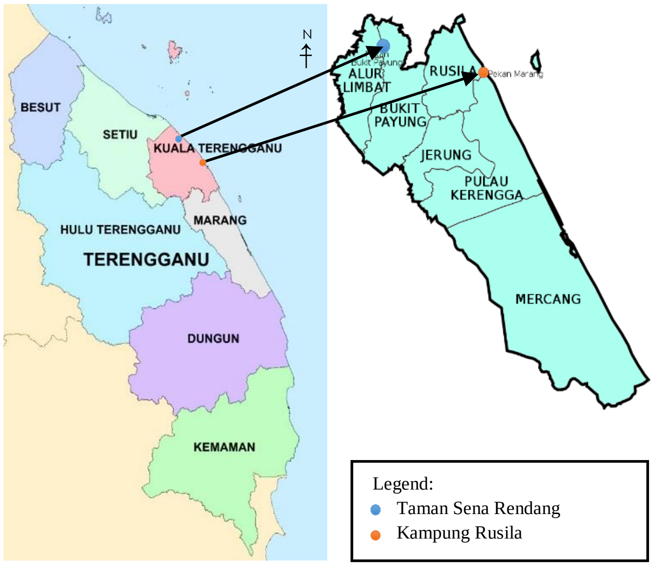

Figure 1. Location of Taman Sena Rendang and Kampung Rusila in Marang District

2.2. Study Design

This cross-sectional research aimed to determine the Aedes mosquito’s pattern and density in Taman Sena Rendang and Kampung Rusila, Marang Terengganu. This research consisted of five significant steps, indicated in Figure 2.

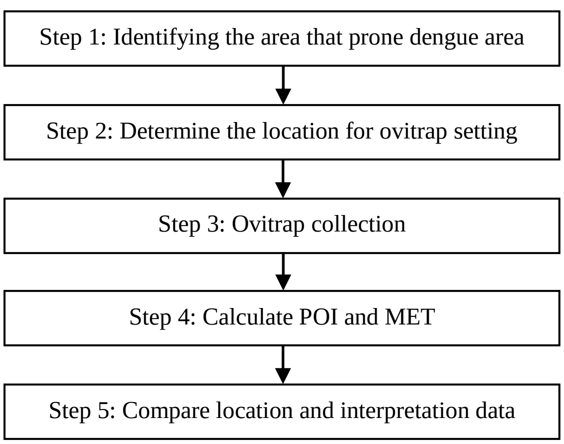

Figure 2. Summary of steps in ovitrap surveillance

Step 1 involves the identification of dengue prone areas. This is followed by the determination of the location for the ovitrap setting. Once the location had been determined, ovitrap installation was carried out. The ovitraps were placed both indoor and outdoor by observing the infection rate both inside and outside of the house and the species of mosquitoes involved in the infection (Mackay et al., 2013).

Once installed, the ovitraps were collected again after five days (Lau et al., 2013). The number of eggs collected is documented. This process was repeated for six months. Following the sixth month, POI and MET were calculated, while the final step involves comparative analysis and data interpretation.

2.3. Identifying Area Prone to Dengue

The location was based on the occurrence of dengue cases. Dengue cases occur in Taman Sena Rendang and Kampung Rusila frequently, contributing to the increase in dengue cases in the Marang district. The total population in Kampung Rusila was 2548, while in Taman Sena Rendang, it was 1475 at the time of data collection. This study area was selected based on population density and other physical characteristics. Apart from the fact that Taman Sena Rendang had a smaller population compared to Kampung Rusila, the housing estate area in Taman Sena Rendang had an organized drainage system and an organized garbage disposal system. However, Taman Sena Rendang has some unoccupied houses that had been abandoned for a long time.

For Kampung Rusila, there was no proper drainage system, and the garbage disposal system was only burned or planted near their respective residential premises. In fact, most houses in Kampung Rusila still use wells as their primary source of water. According to Seidahmed et al. (2018) drainage system that had not functioned well could've been a breeding site for *Aedes* sp.

2.4. Determining the Location for Ovitrap Setting

Taman Sena Rendang was located at the border between Bukit Payong and Alor Limbat (5.243108°N, 103.114746°E) as shown in Figure 3. The housing estate consists of 38 bungalow units, 32 semi-d units, 30 village houses, and five abandoned lands. Kampung Rusila is located between Kuala Terengganu and Marang district (5.242232°N, 103.186132°E) as shown in Figure 4. While, Kampung Rusila area consists of 130 village houses, and there was a mosque in the village.

Figure 3. Location for installing ovitrap in Taman Sena Rendang

Figure 4. Location for installing ovitrap in Kampung Rusila

Ovitraps were installed within a radius of 200-meter, both inside and outside of the houses. As for uninhabited areas or long-abandoned homes, ovitraps were installed on the front porch of the house. A total of 15 ovitraps were placed inside and outside the homes of each locality each week for 6 months. This brings the collective total of ovitraps to 780.

2.5. Ovitrap Collection

Once installed, the ovitraps were collected after seven days and replaced with new ovitraps and paddles for the following week. The paddles were returned to the laboratory after being packed in a transparent plastic bag. The contents of all collected ovitraps from the sites were put into plastic trays and returned to the laboratory. The trays were filled with tap water, and all of the larvae were allowed to grow to adulthood in the laboratory. The paddles took at least 24 hours to dry at room temperature. The eggs on the paddles were examined with a stereomicroscope, similar to methods specified in (Hasnan et al., 2016).

The larvae found in the ovitraps were counted and identified. *Aedes* larvae hatched from the eggs were identified at stage three or four. Any larvae that could not be recognized during the larval stages were allowed to mature into adults, after which they were identified.

2.6. POI and MET Calculation

To assess the population abundance of *Aedes* mosquitoes' eggs, entomological indices such as positive ovitrap index (POI) and mean eggs per trap (MET) recommended by the ministry of health was calculated. The POI values represent the mosquitoes' distribution, while the MET value indicates the abundance of the vector population (Resende et al., 2013). This allows the research to determine *Aedes* mosquito distribution and abundance in both dengue risk areas. The calculation for both POI and MET is as follows:

$$\text{Positive Ovitrap Index (POI)} = \frac{\text{number of positive traps}}{\text{number of inspected traps}} \times 100$$

$$\text{Mean Egg per Trap (MET)} = \frac{\text{number of egg}}{\text{number of positive traps}}$$

2.7. Data Analysis

Once POI and MET for both locations were calculated, these data were statistically analysed for the significant difference using SPSS. The descriptive analysis is presented in the form of mean and percentage. T-test was carried out to identify significant differences in the POI and MET for both locations. The level of significant had been set at *p*-value < 0.05.

3. RESULTS AND DISCUSSION

3.1. Determination of Positive Ovitrap Index (POI) in Taman Sena Rendang and Kampung Rusila

The study was conducted for six months, from epidemiology week 27 to 52. Throughout the study, 15 ovitrap containers were used inside and outside each of the premises, bringing to a total of 780 ovitraps throughout the two districts. The purpose of the installation was to identify the POI index for both locations as this study aims to obtain comparative information between the localities of Taman Sena Rendang and Kampung Rusila.

Based on Table 1 and 2, a total of 746 (95%) ovitraps were in good condition, while 30 (4%) ovitraps were damaged and 4 (1%) ovitraps were missing. All ovitraps were collected and its contents recorded, culminating in 595 larvae detected, with 240 adult *Aedes* mosquitoes and 1,030 eggs.

Table 1. Summary of ovitrap installation information in Kampung Rusila (n=390)

No. of ovitrap	Location of ovitrap		Ovitrap condition during collection, n			Result, n			
	Location	Out/In	Good	Broken	Missing	No. of larvae	No. of egg		No. of adult
							Paddle	Sticky	
1	477-1	In	26	0	0	2	0	27	15
2	477-1	Out	26	0	0	10	21	0	21
3	461-1	In	25	1	0	29	27	0	4
4	461-1	In	24	2	0	0	0	0	15
5	451-1	Out	25	1	0	5	12	0	3
6	451-1	In	23	2	1	34	12	0	6
7	471-1	In	26	0	0	97	230	44	22
8	471-1	Out	25	1	0	69	97	33	17
9	443-1	In	25	1	0	16	54	0	16
10	443-1	In	25	1	0	0	0	0	8
11	468-1	Out	24	1	1	24	25	0	3
12	468-1	In	25	1	0	0	0	15	16
13	PPRT NO.9	In	23	3	0	0	0	0	0
14	PPRT NO.9	Out	26	0	0	12	0	6	23
15	436-1	In	25	1	0	54	44	10	5
	Total		373	15	2	352	522	135	174

Table 2. Summary of ovitrap installation information in Taman Sena Rendang (n=390)

No. of ovitrap	Location of ovitrap		Ovitrap condition during collection, n			Result, n			
	Location	Out/In	Good	Broken	Missing	No. of larvae	No. of egg		No. of adult
							Paddle	Sticky	
1	6551	In	24	2	0	4	0	0	6
2	6551	Out	23	2	1	25	24	0	10
3	6552	In	24	2	0	32	72	11	1
4	6552	In	24	2	0	16	27	10	5
5	6553	Out	25	1	0	17	19	5	6
6	6553	In	25	1	0	18	36	0	2
7	6554	In	26	0	0	20	24	3	5
8	6554	Out	25	1	0	7	25	0	7
9	6555	In	26	0	0	36	30	11	5
10	6555	In	25	1	0	2	8	0	2
11	6556	Out	25	0	1	24	16	10	3
12	6556	In	25	1	0	18	14	0	5
13	6557	In	25	1	0	10	9	6	2
14	6557	Out	25	1	0	2	3	3	7
15	6558	In	26	0	0	12	7	0	2
	Total		373	15	2	243	314	59	66

3.2. Determination of Eggs Abundance based on Mean Eggs per Trap (MET)

Figure 5 showed the MET values for Kampung Rusila and Taman Sena Rendang starting from epidemiology week 27 to 52. The lowest MET recorded in Kampung Rusila was in December, which was 6, while the highest reading was in October, which was 50. For Taman Sena Rendang, the lowest MET number recorded was on October with the MET value of 6, while the highest reading was obtained in November which was 11.

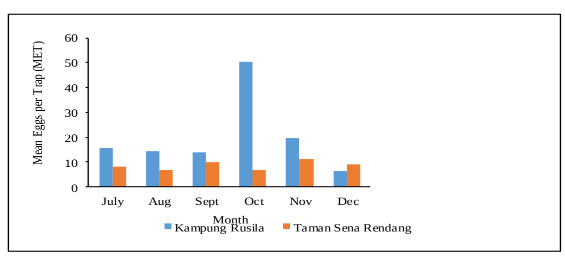

Figure 5. MET values for Kampung Rusila and Taman Sena Rendang

3.3. Comparison of POI and MET Between Kampung Rusila and Taman Sena Rendang

The POI value for Kampung Rusila and Taman Sena Rendang starting from epid week 27 to 52 were plotted and presented in Figure 6.

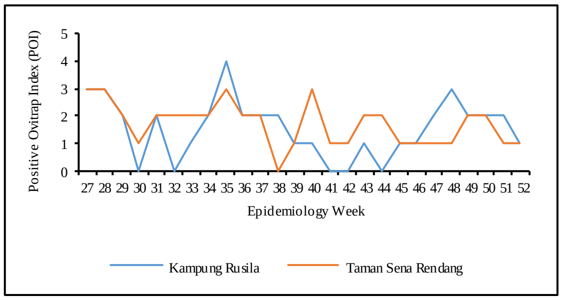

Figure 6. POI values in Kampung Rusila and Taman Sena Rendang

The total number of POI in Kampung Rusila during the six months was 40 containers. The highest POI was recorded in Kampung Rusila in epid week 35, with 4 POI obtained, whereas no POI was obtained on epid week 41 and 42. Meanwhile, POI in Taman Sena Rendang was recorded as 44 containers. The highest POI in Taman Sena Rendang started in epid week 27, 28 and 40, with 3 POI obtained, while in epid week 38, no POI was obtained.

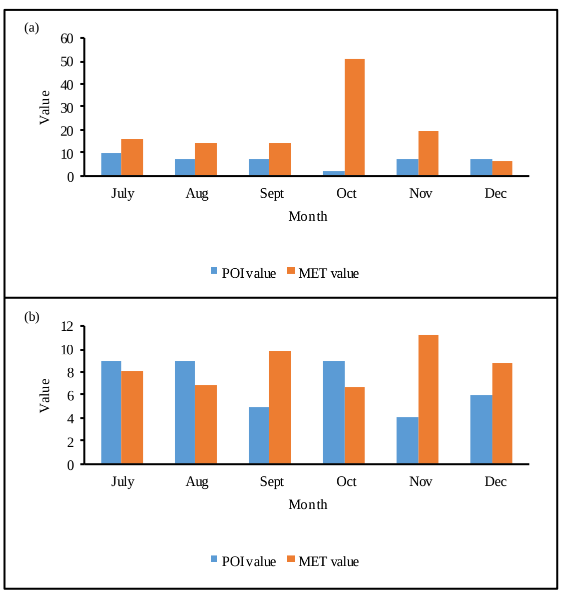

Figure 7. POI versus MET in (a) Kampung Rusila, (b) Taman Sena Rendang

Figure 7(a) showed the comparison between POI and MET in Kampung Rusila over the six months the study was conducted. The highest figure recorded for POI was in July, with a figure of 10 POI recorded. Meanwhile, the lowest figure for POI was in October, when only 3 POI were recorded. As for MET, the highest figure was recorded in October, with a value of 50 MET recorded. Meanwhile, the lowest MET was in December, with only 5 MET recorded for Kampung Rusila.

Figure 7(b) showed a comparison over the six months the study was conducted. The highest figures recorded for POI in Taman Sena Rendang were in July, August and November, with 9 POI recorded. Meanwhile, the lowest figure for POI was in November, when only 4 POI were recorded. As for MET, the highest figure was recorded in November, with a value of 11.23 MET recorded. Meanwhile, the lowest number for MET was in October, with only 6.6 MET recorded.

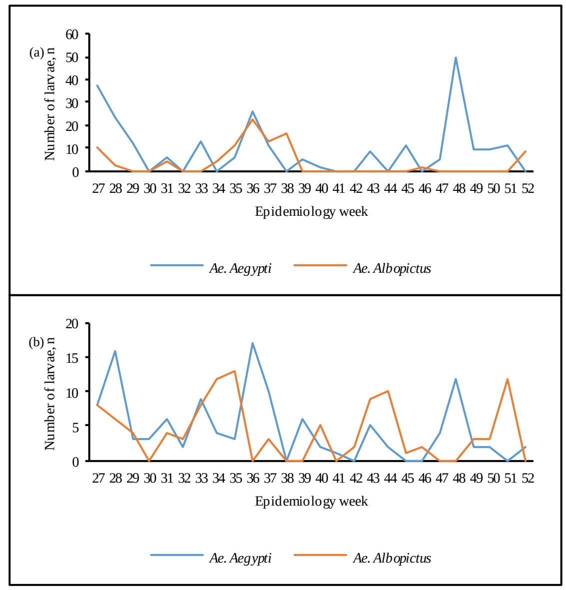

Figure 8. Number of larva according to mosquito species from epidemiology week 27 to 52 in (a) Kampung Rusila, (b) Taman Sena Rendang

Figure 8 showed the comparison number of *Ae. albopictus* and *Ae. aegypti* larval species recorded starting from epidemiology week 27 to 52. In Kampung Rusila, 352 larvae were obtained, of which 334 (95%) larvae were detected with *Aedes* species. Out of 334, 243 (73%) larvae were identified as *Ae. aegypti*, and 91 (27%) were *Ae. albopictus.* Meanwhile, in Taman Sena Rendang 243 larvae were obtained, 228 (94%) are of *Aedes* species. Out of 228, a total of 120 (53%) larvae were identified as *Ae. aegypti* and 108 (47%) *Ae. albopictus*.

Ae. aegypti larvae recorded the highest number in epidemiology week 48 with 50 larvae detected, while the larvae of *Ae. albopictus* recorded the highest number in epid week 36, with 20 larvae detected in Kampung Rusila. Meanwhile, in Taman Sena Rendang, *Ae. aegypti* larvae recorded the highest number in epidemiology week 36 with

17 larvae detected, while the larvae of *Ae. albopictus* recorded the highest number in epidemiology week 35, with 13 larvae detected.

Based on the data obtained, there was a decrease in MET and larvae in July to September in both study localities, and this is because, in that month, movement control orders were made at that time in both localities. Most people in both localities were spending most of their time at home, and they had cleaned up their respective home areas. This is in line with the current study where the first stage of MCO did reduce the dengue transmission in the country (Ong, Ahmad & Ngesom, 2021). However, there was an increase in MET and larvae in September, where prolonged rains led to a rise number of *Aedes* mosquitoes, especially *Ae. aegypti* species in both localities. This is in line with previous study where *Ae. aegypti* mosquitoes are more dominant than *Ae. albopictus* mosquitoes during the rainy season because rural communities develop more artificial containers for internal *Aedes* vector reproduction rather than outdoor reproduction during the wet season (Boonklong & Bhumiratana, 2016).

Availability of artificial containers in urban and rural regions tends to increase during the dry season, although the external and interior divides remain similar. There is a natural inclination for containers to be available for breeding *Aedes* mosquitoes outside in the natural container type MET data for *Ae. aegypti* were also higher than *Ae. albopictus* in both study localities, this result was also similar to the findings of other journals, which stated *Ae. aegypti* dominance in urban settings is linked to its great anthropophagy and domesticity (Serpa et al., 2013).

Table 3. Comparison of MET and POI values between Kampung Rusila and Taman Sena Rendang using independent t-test analysis

Variables	Kampung Rusila Mean (SD)	Taman Sena Rendang Mean (SD)	*p-value*
MET	20.00 (6.32)	8.56 (0.73)	0.076
POI	6.67 (1.05)	7.00 (0.93)	0.817

Data analysis in Table 3 indicates no significant difference between the POI and MET for both localities (*p-value* > 0.05). Both study locations showed POI and MET exceeded the *p-value* > 0.05 where the *p-value* for POI was 0.817, and MET is 0.076. This indicates that both POI and MET values for Kampung Rusila and Taman Sena Rendang are similar even though Taman Sena Rendang has a much smaller population than Kampung Rusila. This is similar to the study made by Serpa et al. (2013), stating no significant difference between location and population in the study area because the change of rainy season can also be attributed to the increase of *Aedes* mosquitoes, especially *Ae. albopictus* mosquito because there are many natural and artificial containers outside the house.

A study by Noor Afizah et al. (2018) also showed no significant difference between AU7 Keramat and Section 7 Shah Alam. The suburban setting with lush vegetation may be to blame for the high population of *Ae. albopictus* on this site. Furthermore, there were busy construction sites near the sampling location throughout the study period, which may have helped establish water stagnation and subsequently provided a natural breeding ground for *Ae. albopictus.*

In this study, ovitrap surveillance was used to access information in the study area on dengue vector density. According to Noor Afizah et al. (2018), most local health authorities utilize the ovitrap method of vector field surveillance because it provides more accurate information and data on the number and spread of *Aedes* mosquitoes. Based on the results of this 6 -month study, the data shows that the POI accumulated in both localities is 92 POI, with a total POI of 40 in Kampung Rusila and 52 in Taman Sena Rendang. Meanwhile, MET data recorded at 120 for Kampung Rusila and 52 for Taman Sena Rendang.

The results showed that Kampung Rusila showed higher POI and MET than Taman Sena Rendang. This is due to the fact that *Aedes* mosquitoes - both *Ae. aegypti* and *Ae. Albopictus* - now dominates both indoors and outdoors. Both species can be found in Peninsular Malaysia's rural, suburban, and urban settings (Pang & Loh, 2016). In Malaysia, *Aedes* mosquitoes of the *Ae. aegypti* type is typically found in homes, reproducing water and food containers (Norzahira et al., 2011). The findings of this investigation can be used to determine how the *Aedes* population can be monitored continuously throughout the ovitrap study. The deployment of this ovitrap can serve as an early reminder of the system, assisting decision-makers in launching vector control efforts.

However, this study was limited due to lack of equipment and manpower. This study showed that the larvae of *Ae. aegypti* is higher than *Ae. albopictus*. Even so, perhaps the very low probability of the presence of *Ae. albopictus* may have contributed to this figure. Studies can be done comprehensively if it had been carried out jointly with local authorities. One of the solutions is to work with the District Health Office in collecting more data and using all available resources for data and information accuracy, in dealing with the dengue outbreak.

The information gathered in this study will aid in selecting test and control locations while also providing critical entomological information for the development of an efficient integrated vector control program to battle *Aedes* mosquitoes in this area.

4. CONCLUSION

From this study, it was found that ovitrap is a reliable tool for vector control and surveillance to attract and capture *Aedes* mosquito species. There are many advantages to using ovitrap. This method is efficient and beneficial because of its low cost. Besides, this ovitrap setting is easier to follow and solve. When a sufficient number of ovitraps are used and often maintained, the vector population can decrease.

POI readings result from the density and the spread of *Aedes* mosquitoes that will be obtained by using ovitrap. In addition to POI readings, ovitrap can also be used to determine the number of *Aedes* mosquito eggs and determine MET results. Therefore, this study can help confirm ovitrap as a reliable and sensitive tool in detecting the presence of *Aedes* mosquitoes. Based on the results of this study, the Positive Ovitraps Index (POI) and Mean Eggs per Trap (MET) show that Kampung Rusila is higher compared to Taman Sena Rendang; these results show several factors that influence POI results. One of the factors that may have contributed to the difference in results is due to the external environment. In Kampung Rusila, especially, there were thick bushes, and the lack of proper waste management systems contributed to a dirty environment. Informal observations during data collection showed many unused containers that may provide space for mosquitoes to breed.

Based on the results of POI and MET, the study area showed that this area has a high risk of dengue cases but is still under control. Mosquito bites can be avoided and controlled in a variety of methods. Mosquitoes can be kept out of their homes by using window and door coverings or locking doors and windows. Furthermore, using air conditioning may keep the house cool and mosquito-free. Fogging activities and larvaciding activities are not the only way to kill adult aedes mosquitoes and larvae, as living area cleanliness is also very important, such as always holding community clean-up among the locals without waiting for the local authority to organize the activity. Elimination of the *Aedes* mosquito is critical for dengue prevention, and it requires the cooperation of all stakeholders.

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