The Impact of Preventive Fogging on Entomological Parameters in a University Campus in Malaysia

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ABSTRACT

Introduction: Preventive fogging is defined as space spraying of insecticide against mosquitoes in order to prevent outbreak of mosquito borne infection. Despite provision of various preventive and control activities against dengue and chikungunya infection by Ministry of Health Guideline, the detail on preventive fogging has not yet specified. However, this has been adopted by certain institutions as part of the routine strategies against dengue outbreak. A study on preventive fogging was conducted in one of the hostels in Universiti Putra Malaysia. The research was done for 16 weeks in which one routine fogging activity was done at the mid period of study. The main objectives of this study were to determine the effectiveness of preventive fogging activities against *Aedes* mosquitoes and to identify the distribution and abundance of *Aedes* mosquitoes in the area. **Method:** The fogging activity was carried out by the management staff as part of their preventive measures in the student hostels. Ovitrap was used as an indicator to monitor the impact of fogging activity and its continuous surveillance was monitored weekly. The ovitraps were placed indoors and outdoors. Species identification was carried out in the laboratory. The SPSS program was used to analyse the statistical data on the effectiveness of fogging activity. Larval count (indoors and outdoors) and ovitrap index (OI) readings were identified as ovitrap surveillance data for statistical analysis. **Results:** The results showed that *Aedes albopictus* was the only species of the genus *Aedes* found in this hostel. The area had been highly infested by *Ae. Albopictus* as indicated by high Ovitrap Index ranging between 48.33% to 90.00%. The mean (SD) of Ovitrap Index was reduced from 71.67% (12.73%) (before the preventive fogging), to 69.42% (14.40%) (after the fogging). Overall reduction in mosquito and larval density was also observed between pre and post fogging activity in this study. **Conclusion:** The implementation of preventive fogging has favourably reduced the dengue vector population up to 5 weeks after the introduction of preventive fogging. However, sole dependency on preventive fogging may lead to insecticide resistance. Revisiting the policy on preventive fogging; and identifying it as an additional tool for preventing dengue infection in higher learning institutions are recommended.

Keywords: Preventive fogging, *Aedes*, dengue fever

INTRODUCTION

Dengue fever (DF) and dengue haemorrhagic fever (DHF) have remained the most important arthropod-borne viral diseases of human worldwide with an estimation of 2.5 billion worldwide are at risk of being infected yearly [1]. It is also an endemic disease in more than 100 countries including Malaysia, which has reported cases of dengue outbreaks in all states [1, 2, 3].

There are basically four main approaches to control and prevent dengue i.e. through biological control, chemical control, environmental management and integrated vector management [2, 4]. Despite the comprehensive review of epidemiological data on these four approaches, space spray (fogging) has been used as the most acceptable method particularly during outbreak in South East Asian countries [5]. The fogging activities are carried out to rapidly eliminate adult *Aedes* mosquitoes in the outbreak areas. Recent development has prompted controversy on the effectiveness of fogging itself. Available studies have shown that space spraying has minimal impact on disease incidence even though the peak of the epidemic may be delayed [2, 6]. The evidence of resistance against pyrethroids, a chemicals which are currently used as main insecticide in fogging activities has further raised the doubt on the effectiveness of the fogging activity [7].

In Malaysia, the trend of the diseases was consistently in an upward pattern with fluctuations in between (Figure

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1). As there is still no vaccine and definitive treatment for dengue, vector control through several approaches has been implemented as the single main strategy. Dengue control in our setting has been done primarily based on case surveillance of suspected cases by doctors and vector control units by space spraying of insecticides (fogging) [8]. Vector surveillance is usually done regularly by larval surveys of *Aedes* mosquitoes and enforcement of DDBIA (Destruction of Disease Bearing Insect Act 1975) by the health authorities [9].

Practice of preventive fogging as a preventive measure has not been listed as one of the recommended strategies. Preventive fogging is defined as space spraying of insecticide against mosquitoes in order to prevent occurrence of outbreak due to mosquito borne infection [10]. However in practice, since there is no clause provided in legislative documentations, the implementation has been mandated to the management of any institution/ organization as part of fulfilling the public or managerial request [10]. In Universiti Putra Malaysia, we observed several occasions where fogging had been carried out as part of an effort to curb dengue outbreak particularly before the starting of new academic session and before the examination week. This has been confirmed based on subsequent interviews with the doctor in-charge at the University Health Centre who mentioned that beside a fogging activity, source reduction by eliminating the potential breeding areas as well as putting the larvicide in the potential water containers [11] have also been carried out. The procedure of fogging usually follows the recommendation by the Ministry of Health. However, for the formality and administrative purposes, to date, no available written guideline for conducting this procedure is available so far. This study was conducted to evaluate the usefulness of preventive fogging as part of integral efforts to curb dengue infection in the campus.

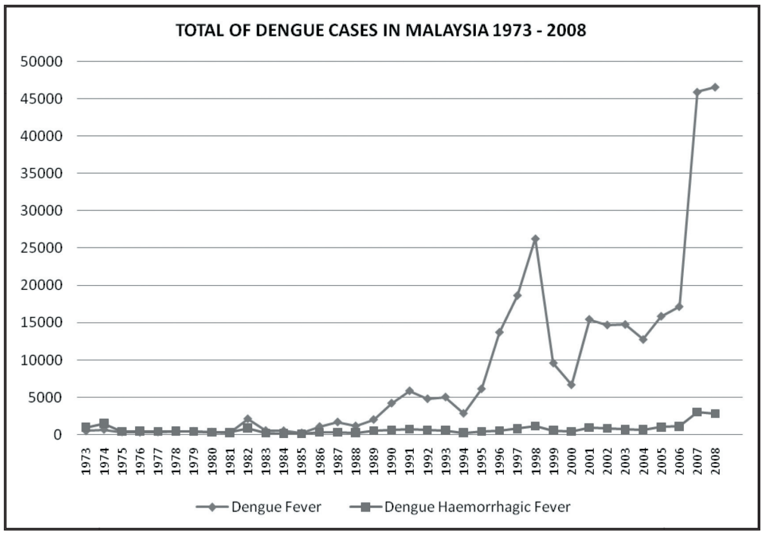

Figure 1. Total of dengue cases in Malaysia 1973-2008 (Source: Ministry of Health, 2009)

MATERIALS AND METHODS

Study area

One of the hostels in Universiti Putra Malaysia was selected as a study area. The hostel consists of five blocks and each block has four floors. Several student utilities are located at the hostel compound such as commercial bank, Post Office and fast food cafeteria. Sparse vegetations can be found at the surrounding campus. There were abundance of breeding sites for *Aedes* mosquitoes found in this area especially around the big trees, fish pond, peacock aviary, various types of artificial containers, drains and unused toilet.

Climate

During the period of study, the hostel area experienced a tropical climate with an average temperature of 25^{o}C to 35^{o}C and the relative humidity of 75% to 95%. The total annual rainfall in all study sites exceeded 2200 mm.

Local dengue control strategy (at the study area)

Fogging activity in the hostel is done in two modes i.e. as a compulsory measure as well as a preventive measure. A compulsory measure is conducted following any reported (suspected/confirmed) case of dengue. In response to any dengue case notification, the activity is usually conducted in collaboration with the nearest District Health Office in

Petaling Jaya.

As for prevention, the fogging activity is carried out twice per semester and it usually is carried out in the late evening by using hand-fogger machine. Pyrethroid (Aqua-Resigen ® which consisted of S-biollatherin 0.14% w/w, permethrin 10.11 % w/w, piperonyl butoxide 9.96% w/w, inactive base 79.79% w/w) was used as the common chemical insecticide for the fogging activity [11]. Apart from preventive fogging, there was also source reduction and larvicide activity using temephos (Abate ®).

Ovitrap surveillance

Continuous ovitrap surveillance [12] was monitored for 16 weeks, which were 8 weeks before and 8 weeks after the preventive fogging activity i.e. from January 2007 until April 2007. In each cycle, the number of immature mosquitoes was collected from the designated areas and species identification was done in the laboratory. Favourable breeding conditions were provided such as dark, water holding containers which were placed in close proximity to a human population upon which the mosquitoes can feed. It has been recommended that breeding sites should be in clean water, possibly with a small amount of organic matter as larval food supply [13]. The creation of the ovitraps followed the *Aedes* mosquitoes preference i.e. to lay eggs on the rough, moist surfaces, just above the water line [14].

The ovitrap consisted of black paint coated plastic container (300 ml), slightly tapered sides. The diameter of the opening measures 7.8 cm with the base (diameter) was 5.7 cm and 11.5 cm in height. An oviposition paddle (substrate) was made from plywood cardboard (13.5 cm x 4 cm x 0.3 cm) and was placed diagonally into each ovitrap.

Sixty-six (66) ovitraps were set indoors and outdoors [10]. "Indoor" is referred to the interior of the house, while "outdoor" is referred to outside of the house but confined to the immediate vicinity of the buildingas proposed by Lee 1992 [12]. In this study context, house is referred to the student hostels. The ovitraps were placed randomly (fixed to identified area throughout the study period), approximately 25 - 30 meters apart.

Data analysis

For the evaluation of the effectiveness of preventive fogging activities, the larval count used for the analysis as the followings.

1. The mean number of *Aedes* mosquitoes larvae (before and after introducing the control measures)
   = The total larvae count for pre/post control measures
   Duration of study for pre/post control measures
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2. Ovitrap Index (01), the percentage of positive ovitrap against the total number of ovitraps recovered for each study sites.
3. The comparison between mean number of larvae count and also mean ovitrap index pre and post introduction of control measures.

The paired t-test was used for the comparison of larval count before and after the fogging activities. The comparison was made in 8th week i.e. before routine fogging and a few weeks after the routine procedures. The level of statistical significance was determined at $p< 0.05$ by using SPSS (Statistical Package for Social Science) version 16.

RESULTS

In general, preventive dengue control activities in the hostels will be done in response to administrative circular from University Health Center. The circular basically reminds the management of the hostels to carry out the dengue control activities to prepare the hostels for new academic session as well as before the examination weeks. However, the observation in the field during the study period however showed that despite the circular, there were only preventive fogging and removal/ discard of the rubbish or potential breeding containers in the hostel areas. The removal of the potential breeding areas however was done throughout the semester. There were no larvicidal activities (using temephos or any other recommended larvicides in the market) during the observation.

Based on the *Aedes* mosquito identification, only *Aedes albopictus* was found, both in outdoor and indoor areas. Apart from *Aedes* mosquitoes, *Culex* mosquitoes were also found in ovitrap with other insects.

According to the larval count and identification, most *Ae.albopictus* was found near the peacock's aviary, fish pond, below the staircase and adjacent to big trees areas. The ground floor level of the hostel also showed the highest number for larval count compared to other floors.

The fogging activity

In this study, one preventive fogging activity was carried out at the hostel. It was done at 8th week of the study period.

The result showed that this area was highly infested with *Ae. albopictus* populations as shown by high Ovitrap Index which ranged from 48.33% to 90.00%. The mean (SD) number of larvae collected before the fogging activity was 745.00 (259.97), while post-fogging was 678.50 (337.45). The mean (SD) of Ovitrap Index was reduced from 71.67% (12.73%) before the fogging to 69.42% (14.40%) after the fogging activity (Table 1). The number of positive ovitrap collected at this area was decreased from 344 (before fogging) to 332 (after fogging),which recorded a reduction of 3.5%.

Table 1. The mean larval count (LSD) and Ovitrap Index before and after the implementation of preventive fogging activity at the study area

Timing for the control measure	Mean Larval count (SD)			Ovitrap Index (%)(SD)
	Indoor	Outdoor	Both (Indoors and Outdoors)	
Before – preventive Fogging activity	37.50 (22.63)	707.50 (245.09)	745.00 (259.97)	71.67 (12.73)
After - preventive fogging activity	31.50 (22.87)	647.00 (320.83)	678.50 (337.45)	69.42 (14.40)

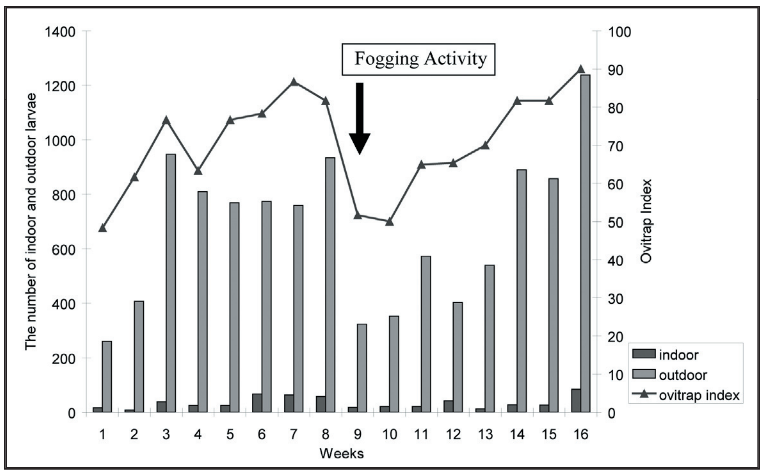

Figure 2. The graph of Ovitrap Index and larval count before and after the implementation of routine fogging activity at Kolej Mohamad Rashid

Table 2. Paired t-test for comparison between mean larval count (per ovitrap) at 8th week and subsequent week (weekly) after preventive fogging

Comparison of larval count at week	Mean (SD)	95% Confidence Interval	t	Sig. (2-tailed)
8th and 9th	12.22 (19.37)	6.77-17.66	4.504	0.000*
8th and 10th	11.63 (19.90)	6.03-17.22	4.172	0.000*
8th and 11th	7.28 (19.00)	1.93-12.62	2.734	0.009*
8th and 12th	10.65 (18.87)	5.34-15.95	4.029	0.000*
8th and 13th	8.02 (23.74)	1.34-14.69	2.413	0.020*
8th and 14th	0.55 (24.57)	-6.36 -7.46	.160	0.874
8th and 15th	1.70 (24.62)	-5.22-8.63	.495	0.623
8th and 16th	-5.78 (25.97)	-13.09 - 1.52	-1.591	0.118

* $p < 0.05$

In general, the larval counts (indoors and outdoors) and Ovitrap Index in this area showed a decreasing trend after fogging activity. The paired t test for specific comparison before and after the routine procedures showed that there were significant difference ($p < 0.05$) of the reduction of the larval counts i.e. between 8th week and 9th week, 8th week and 10th week, 11th week and 11th week; 8th week 12th week; and 8th week and 13th week. Detailed observation showed that the number of larval counts was steadily increased every week after the fogging was done. Surprisingly, it was found that the larval counts were almost similar or higher after 8th week of fogging (Table 2).

DISCUSSION

In this study, only *Aedes albopictus* was found during the larval surveillance. It was quite different from the previous surveillance in the campus area where both *Aedes aegypti* and *Aedes albopictus* were identified as the major dengue vectors in Universiti Putra Malaysia [15] . The ecological background of the campus and the surrounding areas of active development in Putrajaya and Cyberjaya are conducive for the habitats of the mosquitoes. The study area chosen was the oldest student hostels in the campus with its landscape full of scattered vegetation; trees, fencing plants and flowers. There were also a peacock's aviary and a fish pond in the area. This area had several artificial habitats such as uncovered toilet tanks, discarded rubbish in the drains. As it is known that larval breeding sites are very broad and range from natural sites (e.g. bamboo stumps, bromeliads and tree holes) to artificial containers, findings from this study would further support the features of its ecological preferences [16, 17]. *Aedes albopictus* has a strong ecological plasticity that enables it for rapid adaptation to a variety of habitats. Its adaptation to human environments and in suburban environments is well known. However, *Aedes albopictus* has been identified in highly dense urban areas [15]. Furthermore, previous studies reported that only *Aedes albopictus* was found or identified as the dominant vector in major epidemics in regions [18].

The main activities of dengue control and preventive measures conducted by the Health District Office would follow the guidelines of Ministry of Health [9]. In Malaysia and many other South East Asian countries, fogging has still been used as the main control measure during dengue outbreak [5]. Due to the use of fogging as a major approach to curb dengue infection, the public and the authorities are very dependent on the use of chemical control for adult *Aedes* mosquitoes18. Previous study by Chua *et al.* in 2005 [6] documented that, efforts to break the reproductive lifecycle through elimination of the gravid female *Aedes* mosquitoes by application of chemical fogging in natural environment was ineffective.

Standard ovitrap index set by the Vector Control Unit, Ministry of Health recommended that the Ovitrap Index should be less than 5% to classify any place as a low risk area. The Ovitrap Index in this study showed a high percentage readings i.e. ranging from 48.33% to 90.00% throughout the study. Similar findings were also documented in study at other places in Kuala Lumpur and Penang where the OI recorded in the study areas ranged from 40% - 99% [19].

In this study, there was a significant difference in larval count during before and after fogging activities. The differences however only lasted up to 5 weeks after the fogging was done. However, the larval mosquito population in the study area showed a constant upward trend after 5th week of fogging. However, previous studies by Lofgren *et al* 1970 [20], Pant *et al.*, 1971 [21], Uribe *et al.*, 1984 [22] and Mani *et al.*, 2005 [5] pointed the ineffectiveness of the fogging activity. The possible explanation for this is probably due to the re-emergence of the vector population after the fogging activity is completed [23]. Re-emergence of mosquitoes did occur in this study, but it appeared after 5th week of the preventive fogging, which would indicate that preventive fogging could contribute to the reduction of dengue transmission for 5 weeks. The effort, however, maybe more effective if it is integrated with other approaches i.e. environmental friendly strategies namely by the use of biolarvicide (*Bacillus thurigiensis israelensis*) spray, mosquito light traps and continuous effort on search and destroy activities.

Moreover, future research is needed to study the cost analysis of fogging activity and other sensitive parameters to identify the impending dengue outbreak.

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